ELECTRICAL ENGINEERING

MARCH 1942

PUBLISHED MONTHLY BY THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

ELECTRICAL ENGINEERING

Registered U. S. Patent Office

MARCH
1942

The Cover: New 5,400-horsepower four-unit Diesel-electric freight locomotive of the Santa Fe Railway placed in service in 1941, has an over-all length of 193 feet; the weight on the drivers when fully loaded is 923,600 pounds

Santa Fe Railway photo

TRANSACTIONS SECTION

(Follows EE page 176; a preprint of pages 105–68 of the 1942 volume)

VOLUME 61

NUMBER 3

Published Monthly by the

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Founded 1884

HIGH LIGHTS • •

Winding Temperatures on Overloads. Observations on core-type transformers, pertaining to the relation between average and hot-spot copper temperatures and the effect of temperature on the flow of the cooling medium, have suggested a new method of computing winding temperatures reached on overloads from measurements made at rated load (*Transactions pages 133–6*).

High-Speed Breaker. The desirability of inserting an extremely high-speed circuit breaker between the anodes of a mercury-arc rectifier and its corresponding transformer terminal has been demonstrated by operation; a breaker has been developed with an operating speed of one-fourth cycle to the peak of the short-circuit current (*Transactions pages 165–8*).

Performance of Lightning Arresters. Data on the performance characteristics of distribution-type lightning arresters determined from tests have been prepared by the AIEE lightning arrester subcommittee (*Transactions page 132*), supplementing and bringing up to date a similar report published in 1937.

Power Distribution in Wartime. The effect of wartime needs on electric-power distribution systems was the subject of a symposium at the 1942 AIEE winter convention. Present-day standards may have to be relaxed materially in order to carry the loads required by war conditions (*Transactions pages 105–26*).

Wind-Tunnel Drives. The larger and more accurately controlled wind tunnels needed in aerodynamic research require wide variations in speed with extremely close regulation while handling large amounts of power. Two recently developed drives have been described (*Transactions pages 126–30; 156–8*).

Blueprint for Peace. Unless all civilization is to be converted into a permanent arsenal, much of the world must grapple with the problem of converting an armament economy into one of social welfare, the president of the Case School of Applied Science declared in an address at the AIEE 1942 winter convention (*pages 113–19*).

Diesel-Electric Locomotives. The greatly increased use of Diesel-electric locomotives for heavy switching, passenger, and freight service during the past several years has been the result of the rapid developments in the Diesel engine and in electrical equipment (*Transactions pages 130–1*).

Utilization Voltage Range. A standard band of utilization voltages, ranging from 107 to 127 volts with a preferred spread of 110 to 125 volts, has been suggested for the industry, as a means of simplifying the design, rating, and use of equipment (*Transactions pages 142–52*).

Power for War Production. To produce the prodigious amounts of war materials projected in the current program, tremendous amounts of electric energy will be needed. Plans are being made by the Government to assure that no lack of power will limit the war effort (*pages 126–30*).

Engineers and the War. Engineering talent is urgently needed to devise inventions and substitutions to speed the war effort; it will be even more essential in the greater peace effort that must follow, according to a representative of the War Production Board (*pages 132–4*).

Loci for Motor Currents. For a machine of known constants, currents have been evaluated for several speeds and several reactances, and plotted to establish circular loci for conditions of constant speed and constant reactance (*Transactions pages 152–6*).

Rapid-Transit Car Control. A control system utilizing a commutator-type rheostatic motor controller and providing a dynamic service brake has been adapted to multiple-unit operation (*Transactions pages 142–7*).

Complex Integration. The theory of integration in the complex plane, a long-established field of mathematics, has been presented in the second article of the series on advanced mathematics as applied to electrical engineering (*pages 139–43*).

Lighting for Airports. The problem of lighting for airports is one of signaling rather than of illumination; a survey of recent developments has been prepared by an engineer of the Civil Aeronautics Administration (*pages 119–25*).

Winter Convention Report. In many sessions and conferences on timely subjects, the AIEE 1942 winter convention reflected the effects of the United States' entry into the world conflict (*pages 144–61*).

Shielding Transmission Lines. Additional data on the protection of transmission lines from lightning have been obtained from tests with model towers (*Transactions pages 159–65*).

Edison Medal. For contributions in electrical engineering, engineering education, and dielectric research, the 1941 AIEE Edison Medal has been presented to Past President John B. Whitehead (*pages 135–8*).

Civic Activities for Sections. Among interesting features of the 1942 AIEE winter convention was a conference on ways in which Institute Sections and members can contribute to their communities during and after the war (*pages 148–52*).

Brakes for High-Speed Trains. By the use of electropneumatic brakes, the time lags encountered in pneumatic apparatus have been overcome (*Transactions pages 137–42*).

Coming Soon. Among special articles and technical papers currently in preparation for early publication are: an article on wartime power-system planning by R. G. Hooke (M'28); the third in the series on advanced mathematics applied to electrical engineering, an article on Laplacian transform analysis by Jacob Millman (A'37); an article on lightning protection, the third and concluding of the series reviewing progress in protection of electric-power-system circuits and equipment over the past ten years; a paper describing a new instrument for recording transient phenomena by S. J. Begun; three papers describing lightning investigations: one on a power company's 220-kv line, by Edgar Bell and F. W. Packer (M'41), another on a 132-kv transmission system, by I. W. Gross (M'40) and G. D. Lippert (A'38), and the third on tests at high altitudes in a western state by L. M. Robertson (M'38), W. W. Lewis (F'38), and C. M. Foust (M'31); a paper on progress in the development of trolley-coach overhead systems by L. W. Birch (M'29); a paper on operating results with PCC cars in an eastern city by W. J. Clardy (M'39); a paper on the doubly fed machine by C. Concordia (M'37), S. B. Crary (M'37), and Gabriel Kron (A'30); a paper on supplementary control of prime-mover speed governors by S. B. Crary (M'37) and J. B. McClure (A'29); a paper on recent developments in burying telephone cables by Donald Fisher (A'35) and T. C. Smith; a paper on modern electrical equipment for industrial Diesel-electric locomotives by Lanier Greer; a paper on protection and tonnage ratings of single-phase a-c electric locomotives on a large railroad system by H. C. Griffith (M'35); a paper on equivalent circuits for hunting in electrical machinery by Gabriel Kron (A'30); a paper describing improvements in modern meter-testing technique by E. E. Lynch (M'35) and M. A. Princi (A'36); and a paper on the electric strength of nitrogen and Freon under pressure by H. H. Skilling (M'34) and W. C. Brenner (A'41).

Electrical Engineering: Copyright 1942 by the American Institute of Electrical Engineers; printed in the United States of America; indexed annually by the AIEE, weekly and monthly by *Engineering Index*, and monthly by *Industrial Arts Index;* abstracted monthly by *Science Abstracts* (London). Address changes must be received at AIEE headquarters, 33 West 39th Street, New York, N. Y., by the 15th of the month to be effective with the succeeding issue. Copies undelivered because of incorrect address cannot be replaced without charge.

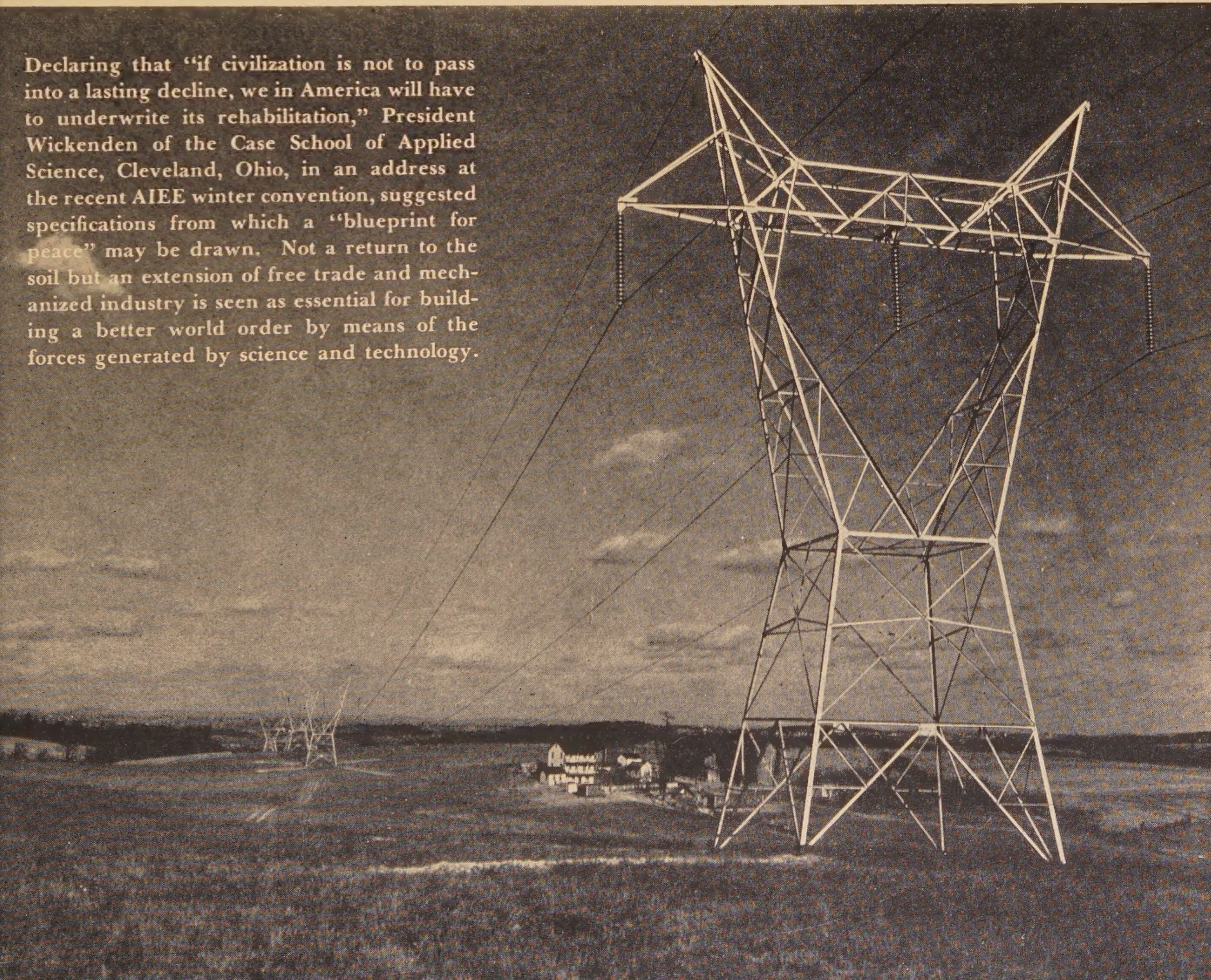
A Peace Worth Fighting For

WILLIAM E. WICKENDEN
FELLOW AIEE

THE name of Edison reminds us that imagination is no less a tool of the engineering profession than fact-bound analysis. The medal which honors the revered memory of Benjamin Lamme bears these words from his pen, "The engineer views hopefully the hitherto unattainable." Kettering is quoted as saying that the difference between a research man and an inventor is that the latter does not know all the reasons why a thing cannot be done, therefore he goes ahead and does it. We engineers who have not only a war to win but also a peace to make secure should pray for a double portion of their spirit.

The 30th of September in 1938 may be marked in future histories as the most tragic date in a thousand years. The Munich pact which sealed the fate of Czechoslovakia not only shattered the tottering structure of world peace, but blasted the last vestige of international good faith on which a new and better peace could be built. Where law had once reigned, only a shadow of law remained, and gangsters were free to take over with impunity. We in the United States, a nation without border complexes to breed an instinct of distrust, were slow to perceive the truth. For three years we moved in a fog of indecision, allowing the shifting pressure of events to shape our course. We had neither enlightened policy nor consistent leadership as our guide. With our political left hand we sought to extend a social revolution, while our industrial right hand was called upon to prepare for a total war. Neither hand trusted or understood the other. Authority was confused and co-ordination lacking. The normal processes of democracy worked badly and the defense results were disappointingly meager and unduly costly. Then came Pearl Harbor.

As if by a flash of lightning, the fog dissipated. The character and the caliber of the foes to be faced stood



Declaring that "if civilization is not to pass into a lasting decline, we in America will have to underwrite its rehabilitation," President Wickenden of the Case School of Applied Science, Cleveland, Ohio, in an address at the recent AIEE winter convention, suggested specifications from which a "blueprint for peace" may be drawn. Not a return to the soil but an extension of free trade and mechanized industry is seen as essential for building a better world order by means of the forces generated by science and technology.

revealed in starkest outlines. Our own weaknesses were pitilessly laid bare. The path ahead grew clear, brutally clear. Grim resolution seized the nation. Yet there was an unmistakable wave of relief, for even brutal certainty is often easier to bear than confusion of mind and conflict of will. Thus like Britain and France before us we were plunged into a war which none but fanatics desired, sadly, reluctantly, without hate, in a spirit of fatalism. Never in modern times had a whole generation of mankind so completely lost its way.

When future historians come to fix a label upon our times it should surprise no one to find this called "the age of Hollywood"—an era that preferred diverting illusions to solid realities; a generation of jazz and jitterbugs, that thought it more important to be smart than to be wise, that preferred glamor out of a make-up kit to charm acquired through painstaking cultivation; an age of unreal Utopias, that fought a war to end wars, that created a League of Nations without police powers, that built peace on political distintegration in a Europe desperately in need of economic integration, that signed the Kellogg–Briand Pact and trusted its security to the deep caverns of a Maginot line; an age—in America, at least—of economic fantasies, that spent the 1920's abolishing poverty by the magic of stock-market inflation and the '30's restoring social security by spending more than was produced, that dreamed of an America made immune from the ills of mankind by broad seas and a tariff wall, an island of peace and of plenty in the midst of a world of want and of woe.

To make a successful peace, it is not enough to have blueprints ready in an official file; it is also necessary to condition people for their acceptance.

In all soberness, I do not believe that thoughtful men are willing to go through an inferno of blood and sweat and tears merely to get our old world back. With all our souls we do not want Hitler's new order of international gangsterism, nor Tokyo's coprosperity sphere, nor Lenin's proletarian Utopia. To lick Hitler and avenge ourselves of Japanese treachery is necessary, but it is not enough. Remembering Pearl Harbor will put a useful shot of adrenalin into our blood stream to spur our immediate efforts, but it will not give us the staying power for a long and exhausting conflict. Faith, not anger or fear, is the greatest source of staying power that human experience has revealed. Faith in what? We are therefore justified in looking beyond the actual conflict to a peace worth fighting for. Experience has shown too often and too clearly that if you do not prepare for defense until your country is invaded, it is then too late; but it is equally true that if you do not prepare for peace until an armistice is declared, it is then too late. A peace conceived in an atmosphere of economic prostration and emotional exhaustion carries within it the germs of its own destruction.

This is a good time to examine the fruits of our experience. Wise men, it is said, make mistakes but fools repeat them. The United States helped once to win a world war as a minor military partner and found itself outvoted at the peace table. As a compromise, its chief negotiator imposed on Europe a new scheme of collective security designed to replace the long-familiar system of a balance of power. The only chance of the novel scheme's success lay in United States participation as a balancing and moderating influence, but our Senate had not been consulted in the planning stages—a fatal error politically—and repudiated it. Unfortunately, the architect of the plan was better versed in political ideals than in economic realities. The ideal of self-determination was allowed to overshadow completely the economic integration which Europe desperately needed. In place of the collective security of Wilson's dreams, a flood of destructive nationalism was let loose on the world.

Having insured the political collapse of the peace structure, we proceeded to its economic sabotage, not by deliberate calculation but by refusing to assume the role into which the war had thrust us. We were innocents abroad, in a world beyond our experience. We had entered the war a debtor nation. For three centuries we had drawn on European capital to develop our land and mineral resources, build our railroads, and equip our industries. We were accustomed to settle the interest account by sending abroad an export surplus each year of 600 millions of dollars. Our market for manufactures was elastic; as costs fell its volume rose behind a tariff dyke. Our market for food, cotton, and other agricultural staples was relatively inelastic, and we found it convenient to let the surplus flow out over the spillway at the ruling prices of the world. In short, the protectionist policy of our prewar years was one well fitted to our economy.

We came out of the war in the unfamiliar role of a creditor nation. On paper, Europe owed us 25 billions of dollars. To collect our interest and spread the amortization over 50 years would mean our taking in an import surplus of a billion a year. The whole idea seemed repugnant to our instincts. Here we were, geared to an immense surplus of production, with Europe hungry, its stocks depleted, its equipment deteriorated, needing everything we could supply. They wanted our goods. We wanted the business. We wanted to sell without buying and expected a settlement in cash. Very well, we would lend them the means to keep the game going, and did so until it blew up in our faces. As to terms, was it not Calvin Coolidge who expressed in his sparse Vermont idiom the verdict of the nation,

Alas for our peace of mind, too many of Europe's tragedies have been in no small measure of our own making.

"They hired the money, didn't they?" In the cold light of experience, we can whistle for the money, forever.

If it is hard to forgive the Harding–Coolidge regime on the League of Nations and the World Court, or Hoover—who of all men ought to have known the rudiments of international economy—on the tariff and the debts, it is also hard to forgive the Roosevelt regime for scuttling the London Economic Conference after sending delegates pledged to co-operation in world rehabilitation, and for embarking on a policy of dollars wild in the poker game of currency devaluation. Alas for our peace of mind, too many of Europe's tragedies have been in no small measure of our making.

But we were not alone in our bungling. Our former allies were not to be outdone. In repeated visits to Germany over a six-year period, beginning shortly after the restabilization of the money and ending only a year before Hitler came to power, I was able to see at first hand the tide turn from hope to despair and from faith in free institutions to the fanatical introversions of blood and race. We had a good chance to save the peace down to the days of Briand and Stresemann. The Germans, I believe, sincerely meant to accept the reparations settlement under the Dawes and the Young plans.

Germany could bear this burden only as a surplus of production over her own elemental needs; lacking raw materials, this surplus could come only from their own intelligence and labor. It meant extra hours of hard work, for the seeming benefit of their recent enemies, but the Germans said they liked to work—they would work 50 hours a week, 50 weeks a year, and 50 years a lifetime. To avoid deranging the economic life of Western Europe, the Germans felt they must be given a free hand to exploit the raw materials and the hungry markets of Russia. In 1926 negotiations to this end were actively under way and Germany was engaged in a most intensive effort to perfect her working tools and operations and to master thoroughly the arts of mass production on American lines. Then the secret began to leak out—the very scale of industrial development and operation necessary to settle the reparation account would inevitably give German industry an overwhelming dominance in all Europe. When the British and the French fully perceived this fact, they refused to go along, setting in motion the policy of progressive frustration which finally drove a not-too-willing Germany into Hitler's arms. It is reported that when one highly respected German consular official in America learned that the Nazis had come to power, he remarked to a friend with a gesture of despair, "The hoodlums have taken over!"

Paradoxical as it may seem, it is not war but its aftermath that destroys nations and threatens civilization. Doctor Harry Emerson Fosdick, New York's famous preacher, illustrates that point with the story of a man who fell from the roof of his house; when a friend asked if the fall hurt him, he answered "No, the fall did not hurt me, it was the stopping that nearly killed me." Human nature, it seems, can withstand the disciplined rigors of war better than the disintegration of peace, as the Hapsburgs, the Romanoffs, and the Hohenzollerns would quite agree. To make a successful peace, it is not enough to have blueprints ready in an official file, it is also important to condition the people for their acceptance. Woodrow Wilson learned this to his sorrow. Returning soldiers, sick of fighting and fed up with their recent allies, and emotionally exhausted civilians homesick for normalcy, cannot be counted upon to build a brave new world.

As a prelude to the problems of peace, we shall have to take some of the risks of prophecy. Some outcomes seem inevitable, no matter who wins the war. There will be world-wide depletion of men, materials, equipment, and liquid wealth. Whole continents will be enfeebled by inadequate nutrition. World-trade, shipping, and banking structures which it has taken two centuries to build will be largely destroyed. Staples like silk and rubber on which trade empires have been built may yield place to synthetic substitutes. The bonds of world empires will be loosened. Primitive peoples who in the past have asked little of life except that their rice bowls be filled will have felt the impact of technological war and technological economy, awakening their craving to share in the means of defense and in the abundance of goods which only an industrial civilization can supply.

Whatever the military outcome, the world is being welded by blood and sweat into larger units in which the economy of mass production and distribution can operate effectively.

Whatever the military outcome, it seems that the world is being welded by blood and sweat into a group of larger economic units in which the economy of mass production and mass distribution can operate effectively. Men everywhere will want to share the American secret of high wages and of more, better, and cheaper goods. Little nations lacking assured access to a great variety of raw materials and to vast and diversified markets are excluded effectually from this system. How to assure to Finns, Danes, Belgians, Swiss, and other small peoples whose contributions to civilization have been unique and precious, freedom of language and culture, together with autonomy of regional and local government, in the larger economic aggregations which seem sure to come, is a problem to give us pause.

In tomorrow's world it may no longer be possible to fence off privileged areas and to possess them in security by virtue of technological pre-eminence or monopoly of basic materials. It may be no longer possible to preserve a \$14-a-day standard of living for the American workman in the presence of a 14-cent-a-day standard for the equally intelligent and incomparably more industrious Chinese coolie. It may not be in our interest to

try to do so. No one expects, and few desire, an immediate equalization of income standards over the world, even though the present conflict should turn out to be a prelude to Utopia, but there are inherent leveling forces in an economy of science and technology which soon must be reckoned with on a world-wide basis. A nation far advanced may hold its favored position for a time by exporting its products while retaining a semimonopoly of technological equipment and skill. This was the classic economic strategy of Great Britain, against which we rebelled in 1776, but which continued to operate in a diminishing degree down to World War I. Sooner or later the advanced nation reaches the point where it begins to export not only goods but tools for producing them, to equip steel mills in Brazil or machine shops in Russia or arsenals in China, and the slow but inevitable leveling process picks up acceleration as one nation after another industrializes.

No matter who wins the war, unless all civilization is converted into a permanent arsenal, much of the world must grapple with the problem of converting an armament economy back into an economy of social welfare. With it we must tackle the problem of restoring a dictated economy to a free economy. The dislocation of a return to peace is beyond our imagining. At the lowest possible estimate, the war's end will find 250 millions of people in Europe, America, and the British dominions entirely dependent for their living on the production of the materiel of war. The incidence of war on the world of production is usually gradual. Hitler spread the transition over seven years in Germany and spent over 90 billions of reichsmarks on war production before the first blow was struck. But the incidence of peace is almost instantaneous; production stops overnight. The Nazis have an answer: war is the normal state of human existence, while peace is a mere interlude in which to replenish population and restock the arsenals. We need a better answer, and finding it is likely to take the full measure of our wisdom and of our planning capacity.

Let us not delude ourselves into thinking of a mere return to the soil as the way back to a peace economy. That door was closed for most of mankind over a century ago. The world's population has considerably more than doubled since 1800; some areas have grown acutely overcrowded. "*Lebensraum*" is a real enough problem when we recall that some 12 Germans or 18 Italians or perhaps 30 Japanese have to contrive to get a living with the aid of natural resources roughly equivalent to those available to the average American. Only mechanized industry and open channels of trade can give *lebensraum* to crowded peoples without pillage. Hjalmar Schacht, the German economic genius, knew that when he said "If goods do not cross frontiers, armies will."

The people of the United States will have problems at home from which no victory can shield us. Debt, for one thing. Last year our public debt—Federal, state, and local—reached a total of 85 billion dollars, exceeding for the first time in our history the corporate debts of our business system and equaling approximately our annual national income. The program of war effort already announced is fairly certain to raise the Federal debt to 150 billion, and no one knows where the ceiling will be. A debt of 200 billions is bearable, and need not invite repudiation, as it represents less than half our national wealth and is roughly twice our annual income. A Federal debt of this magnitude would be roughly equivalent to a public mortgage of 75 cents on every dollar of the nation's productive assets, including farm land and urban real estate. Some measure of inflation is inevitable and the wisest controls will be needed, but debt alone is not likely to cause a runaway. Most of us will recognize inflation when it comes simply as our old acquaintance, Mr. High Cost O'Living. The mere carrying of this debt will impose a severe strain on government finance; it will eat up 3 or 4 billions a year in taxes, and the first \$25 or \$30 of income for each member of the average family will be earmarked in advance for interest charges. Government will find it necessary for its own relief to use every known expedient to hold interest rates and the return on invested funds in general down to the lowest possible level. This will bring no joy either to colleges dependent on endowment earnings or to holders of insurance policies. Competition for tax money among the various units of government—national, state, city, and local—and among publicly supported institutions and social services will grow severe. There will be no will-o'-the-wisp of reparations to buoy up false hopes and no money return from lend-lease operations.

In dealing with the debt, we shall have three possibilities to choose among. Either we shall repudiate the debt by inflation, or grin and bear it, or ease its burden by creating new wealth and a greater national income. Freedom is better than slavery at any price, but only the third of these courses of action can stir our hope of a better age to come.

We shall have not only increased debt, but increased assets as well. On paper, the national balance sheet may not look quite so bad. Not all our war outlay is going to be used up in action. A rough calculation indicates that our capital investment in defense plant may run up to 40 or 50 billion dollars. It will be represented by our enormously increased capacity for producing metals, chemicals, power, aircraft, machine tools, and machine products. If we succeed in making this greatly augmented plant investment earn its way, we shall be well on the road to a solution of the problem of finding employment for our greatly increased working population. If the plans recently announced by the President for 1942 and 1943 are carried out—and they must be—war production and the armed forces together will require the services of about 24 million people, in

comparison with the 16 million ordinarily employed in production industries. Past experience indicates that relatively few of the millions thus added to our employment rolls will voluntarily accept demobilization at the end of hostilities.

Another problem to be faced is the gold hoard now in our possession, five sixths of the entire world supply, valued at some 23 billion dollars. We do well to consider that what gives our gold this value is not its utility in industry and in art, but rather its potential usefulness as a monetary base and especially its unique value as a convenient medium for the settlement of international trade balances. Apart from a free economy such values have little meaning. In Nazi internal economy, currency is merely a government-backed claim against whatever goods are available for civilian consumption; in Nazi external economy, money is merely a reckoning unit in hard-driven barter deals or forced requisitions. Unless we can restore a gold-backed monetary system in the postwar world of international trade, our gold hoard is merely so much lustrous metal, good for filling teeth and making jewelry, with a value fixed by the law of supply and demand.

With these premises, let us confront the issue: is there a peace beyond mere military security worth fighting for? To struggle for self-preservation alone is after all little more than an instinctive fatalism. We crave a higher faith to transform sacrifice into privilege, to face tragedy with fortitude, and to nerve our spirits when the flesh wearies and the will grows faint. Win or lose, the outlook for much of the world is dark. The vanquished must face the peace hungry and exhausted, their goods gone, their productive equipment worn out, the scant remnant of their capital frozen in armament industries, and their social structure together with the ideology that sustained it in utter ruin. Their intellectual and spiritual bankruptcy may threaten a return to the dark ages. Where in all the Nazi world may one look for even a remnant of uncorrupted youth to be the nucleus of a reborn culture? Is there not a Biblical parable of a man who had been cleansed of a devil only to have seven devils move into the empty place? Our allies in victory will at least be the captains of their souls, however stricken in material resources.

It is not too much to say that if civilization is not to pass into a lasting decline we in America shall have to underwrite its rehabilitation. Whatever the cost and wastage of the war may be, I have faith to believe that we shall finish the job with our man power and vigor but little impaired, with our productive capacity vastly increased, and with our trust in human worth and in a free and just society unshattered. True, we shall be burdened with debt and vexed with dislocations, but I believe we can rise above them. Indeed, the surest way to rise above our troubles may be to forget them and dedicate ourselves without reserve to the salvage and spread of civilization which we alone can undertake.

When we come actually to face this issue, no doubt the isolationists will still be with us, counseling us not to waste our shrunken wealth on the down-and-outs, but to wash our hands of the sick world and retire into an economic quarantine. Perhaps they might consent to some sort of swap for coffee and bananas, or for tin and manganese, or for tea and rubber, but as for the rest—let the world go hang. Leaving all humanitarian sentiment aside for the moment, there are certain costs to be counted before committing ourselves to any such self-serving program. We shall have to pay for the war, no matter who fights it. Win or lose the peace, we shall have to pay for it anyway. We can pay for it by withdrawing into a closed economy, which may mean the writing off of a hundred billion dollars of capital, more or less, without chance of recovery; or we may pay for it by underwriting the world's recovery and the extension of civilization, in which case we may not only do some good, but have at least a sporting chance of getting our money back with some profit.

We shall have to pay for the war, no matter who fights it. Win or lose the peace, we shall have to pay for it anyway. If we pay for it by underwriting the world's recovery and the extension of civilization, we have at least a sporting chance of getting our money back with some profit.

Suppose the United States does withdraw into a closed economy, what are the chances of gain or loss? As a start, we should have to write off forever all we are putting into the lend-lease program. Next, we might have to write off some fifteen billion dollars or more of the supposed value of our gold hoard. If gold is just metal, priced by supply and demand, our overstock might be little more than a monument to our folly. Then we might experience difficulty in finding much use for the greater part of the new war-goods plant we are now building. Who will be buying aircraft, or machine tools, or armor plate—or using power, for that matter—in the amounts we will be geared to produce? Not the home market surely. That might mean writing off another 30 or 40 or perhaps 50 billions of capital. And who would buy the extra acreage we are putting into production, beyond our normal requirements, to make good on the food end of the lend-lease program? Who would provide employment in a closed economy for the greatly swollen ranks of our working population? If there are no outlets abroad for what these men and women can produce, may we not expect a new generation of false prophets to arise, preaching salvation by division instead of multiplication, while relief rolls and made-work projects and pump-priming expenditures suck us down even faster into the vortex of national insolvency?

If we do accept the great adventure and decide to risk our wealth on world recovery rather than to hoard

it, we might logically begin by digging our gold out of the vaults of Kentucky for use in re-establishing the world's money system and as a base for international credit. That would mean lending it to recent friend and recent foe alike. If we lend it, we ought to expect some reasonable guarantees. It might do more good and we might have better prospects of a return on it if we placed it in the hands of strong borrowers, with diversified resources that might be organized into a well-balanced economy, than into too many small and weak hands paralyzed by mutual hates. Choosing the borrowers would give us a powerful voice in any economic and political regrouping of the world.

The tragic failure of World War I and its aftermath testifies to the futility of building a new order on political disintegration rather than economic integration. Sovereignty without a decent economic sufficiency is an empty shell. Under the guise of self-determination, the concept of extreme nationalism reached its all-time peak in the last postwar interlude. Sovereignty was understood to secure to each nation its right to manage its fiscal affairs, to devalue its money, to protect its industries by tariffs and preferences, to force its goods on others by intimidation at no matter what cost to its neighbors. And of course, sacred honor gave it the right to make war on anybody at any time. The obsessions of ultranationalism rise but little above the economics of the robber barons. It is only a meager and transient wealth that a man gains by pillaging his neighbors, keeping them poor, and refusing to do business with them. The modern key to wealth is more, better, and cheaper goods, produced in volume through advanced technology by high-paid workmen where supplies of materials are favorable, and sold in the widest markets at the lowest costs. This principle is no respector of political sovereignty. It cannot operate in close confinement.

If the United States is to be the world's banker and use its gold to reanimate the world's atrophied economy, it will be well to remind ourselves that the surest way to guarantee our own prosperity is to create prosperity elsewhere, that the surest way to protect our standard of living is not to quarantine it against the plague of world poverty but to encourage a healthy standard in other lands. We cannot sustain the banker's role by lending our money and immediately taking it back in cash payment for the food, cotton, oil, metal, and industrial equipment the world will be needing so desperately when peace comes. We must insist on the borrower's keeping our money in his business as working capital and using our gold to re-establish his credit. Give or sell we must, or millions will starve and our own economy will languish; but we must sell on long-term credits and be prepared to take other peoples' specialized goods and raw materials in excess of our exports. Our role will be to lead in destroying trade barriers rather than in erecting them.

Any peace worth fighting for must not only keep our own industrial plant working, but insure its gradual renewal and expansion as well. Economists assure us that we cannot prosper by merely producing goods to consume; we must gain added buying power by adding to our capacity to produce. We do this partly by saving, but mostly by borrowing from the future through the mechanism of credit. We then sluice this borrowed capital into added consuming power by spending it for labor, materials, and equipment to build new tools and larger plants. Without this expansive force, it is doubtful if a free economy can survive, much less prosper.

War expansion is now discounting this normal expansive force many years in advance. When peace comes there will be the United States' own war deficits in consumption and the world's tragic depletion to be made up. After a transient postwar boom, then what? Can the expansive force be preserved? The development of new products and new industries, which D. C. Prince has advocated so effectively, will go far, but will that be far enough? Depressions are like epidemics with a world-wide sweep. The forces of economic health must have as wide a scope. Frankly, I see but one chance to preserve the expansive forces of economic freedom and vigor. There are still immense areas of the world which sustain overcrowded populations of hundreds of millions at a bare subsistence level. Primitive agriculture and handcraft hold out no promise of betterment. Human experience offers only one hope, and that is industrialization. The United States alone will have the capital and the productive capacity to tackle the huge job of industrializing such areas as India and China. In doing so we might find our one chance to keep our own wealth working and our own plant going at a real prosperity level.

The postwar role I have suggested for the United States is one that would make unprecedented demands on our faith, our foresight, our restraint, and our organizing capacity. It is a role which no other nation could assume. It calls for the faith to try the key to our own prosperity on the closed doors of the world. It calls for faith to free science and technology from the barriers of an outmoded nationalism. It calls for faith to abandon the idea that America is to be kept as a free and prosperous island in an economically submerged world. It calls for the restraint of refusing to impose either the political or economic overlordship of America and the white race on the retarded areas of the world.

It would also demand an organizing capacity in world affairs which far outruns our experience. In many respects our present partnership with Great Britain may turn out to be almost providential. The circumstances of our entry into the war left us with the greatest freedom of action. We have no obligation to become mere financial underwriters and copolicemen for the historic type of British imperialism. The British, however, have a world experience which we lack, and British experience

and talent may well serve in an expert capacity in the execution of a reconstruction plan of our own conceiving.

The titanic conflict in which we are now engulfed has come upon us as a revolt against the misdirected consequences of human freedom, particularly in the handling of new and vast economic forces generated by the advance of science and technology, in these past 150 years. However much we and our fathers have blundered in the handling of these forces, I have faith that they hold the germs of a new and better world order. Unthinking men who have observed engineers working with equal zeal in both free and totalitarian systems, under capitalism and communism alike—or even embracing the New Deal with enthusiasm—have assumed that we are but abject tools of whatever powers may be in control. That is not the truth. Beneath the surface of our conformity, often silent and inarticulate, a social creed is taking form that transcends the prevailing order. We have faith that science and technology, which know no frontiers of geography or political system, hold potentialities of human betterment as yet dimly recognized. We have a faith—and at times, it can burn with religious conviction—that the well-being of mankind comes through the multiplication of wealth, not through fencing if off, or looting it from the other fellow, or unloading a lot of debt claims on Wall Street, or by distributing a lot of purchasing power through political channels.

We insist that the problems of national security, of social welfare, and of international order must be solved by multiplication and not by division. We insist that our greatest source of multiplied wealth is in new knowledge of nature won through research, in new tools of production, in improved instruments of human living, in more efficient ways of doing work, in more harmonious co-ordination of human effort. We can accept for the moment any political or economic system so far as it works toward those ends, but we cannot accept as final any theory of society or organization of civilization that does not aim at the spread of enlightenment, abundance, and freedom among all men. We are peculiarly the executors of these potentialities in the realm of material well-being. Ours is a profession of imagination, visualization, experimentation, and constructive boldness. Why suggest revolutionary ideas to such hard-headed men as engineers? To whom can we better suggest them, pray tell? We who "view hopefully the hitherto unattainable" have the call to visualize for mankind an economic order that will restore its now shaken faith in human decency and progress, and to sketch the blueprint of a peace worth fighting for.

Airport Lighting

H. J. CORY PEARSON

Many of the recent developments in airport lighting are exemplified at the new National Airport at Washington, D. C.; these and other types of modern practice are presented in engineering detail.

AIRPORT lighting is entirely different in its nature and essential functioning from the illumination problems normally encountered. In general, we are not trying to illuminate anything, so we are not much concerned about footcandles, lumens, absorption and reflection factors, and such. Instead, the problem is more nearly like that of signal lighting of railroads and lighthouses, in that we are interested in using lights primarily as luminous signals. With the exception of floodlighting, all the lights used on the landing area of an airport are intended to be seen by the pilot of the airplane as points of brightness. These lights, by their arrangement, nature, and color, are designed to give the pilot certain information and instructions which assist him in the landing and take-off of his plane.

Let us look for a moment at a picture of the whole airport lighting system in general, such as would, perhaps, be seen by the casual air traveler, landing by night at the new Washington National Airport. I have chosen Washington because at this airport have been installed the latest and most elaborate lighting facilities in the United States. Some of the methods are new and at present only in the experimental stages.

The first identifying mark to be seen in approaching an airport is the beacon. This light, visible for miles to the pilot, tells him that there is a lighted field available. Thus the airport beacon serves the air pilot much the same way as the lighthouse serves the mariner. As the airplane approaches this airport, the outline of the field can be clearly seen marked by distinct lines of white lights broken here and there by red and green

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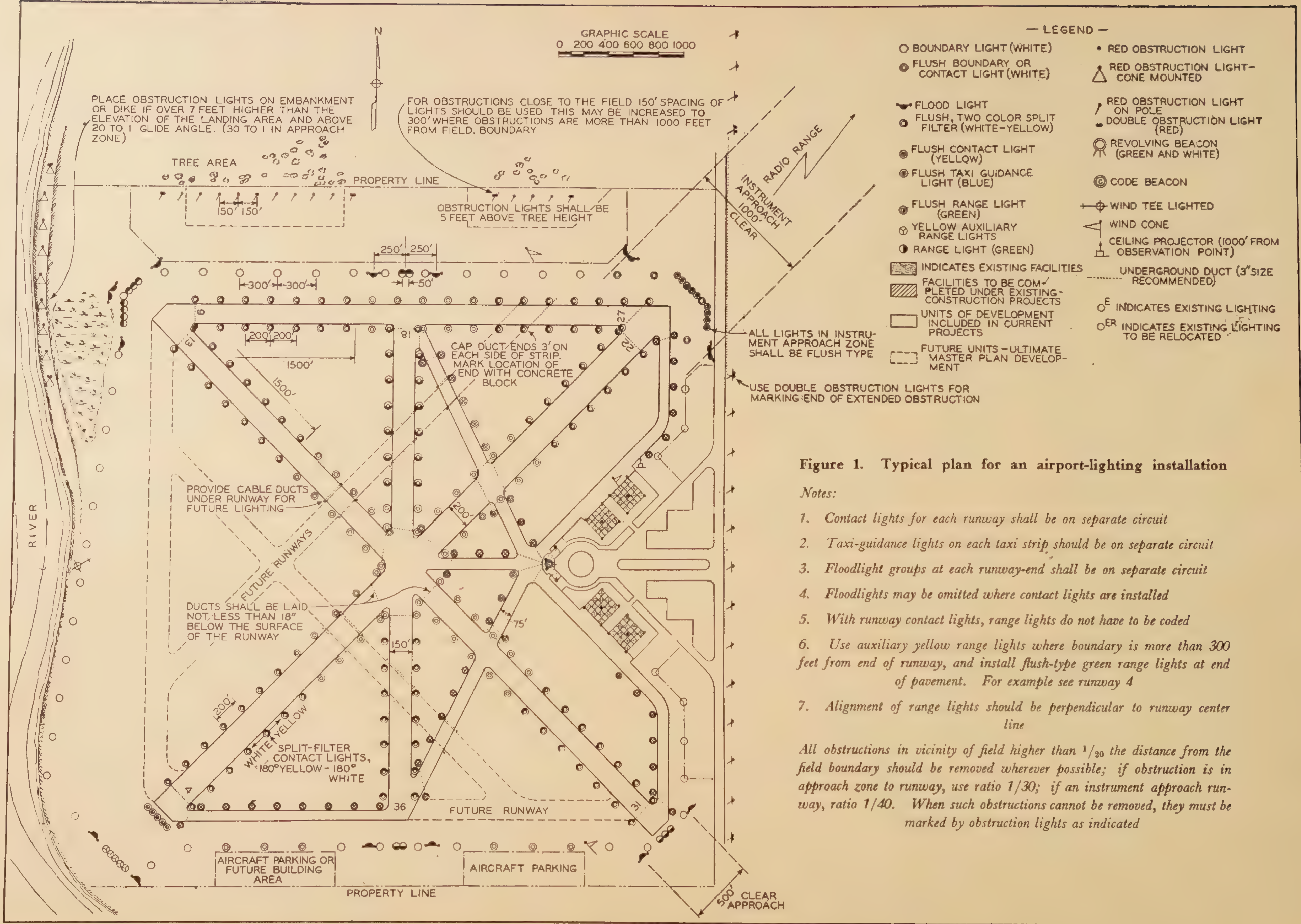

Figure 1. Typical plan for an airport-lighting installation

Notes:

1. *Contact lights for each runway shall be on separate circuit*
2. *Taxi-guidance lights on each taxi strip should be on separate circuit*
3. *Floodlight groups at each runway-end shall be on separate circuit*
4. *Floodlights may be omitted where contact lights are installed*
5. *With runway contact lights, range lights do not have to be coded*
6. *Use auxiliary yellow range lights where boundary is more than 300 feet from end of runway, and install flush-type green range lights at end of pavement. For example see runway 4*
7. *Alignment of range lights should be perpendicular to runway center line*

All obstructions in vicinity of field higher than $^1/_{20}$ the distance from the field boundary should be removed wherever possible; if obstruction is in approach zone to runway, use ratio 1/30; if an instrument approach runway, ratio 1/40. When such obstructions cannot be removed, they must be marked by obstruction lights as indicated

lights. These mark the boundaries, the obstructions, and ends of the runways. As the airplane circles for a landing, a long double line of white lights becomes visible, extending the full length of the field. These are the runway contact lights, marking the runway to be used. If another airplane is taking off, or for some other reason landing is dangerous, a large flashing red cross comes on at the approach of the lighted runway. This signals the pilot not to land.

When the runway is clear the red cross vanishes and a steady green arrow appears in its place, signaling "all clear for landing." In addition two floodlight projectors, one at each side of the near end of the runway, are turned on, lighting the ground along which the airplane is to land. As the pilot nears the ground he can see a bright yellow stripe glowing down the middle of the runway. This is the center marker stripe, painted on the runway and made visible by the floodlights or the airplane's landing lights.

When the airplane has landed and slowed enough to be able to turn off of the runway, the white contact lights go out and a line of blue lights appears along the side of the runway to the left of the pilot. These are the taxi-guidance lights, arranged in banks along the left side of the runways and taxi strips leading toward the loading ramp. By following the path of these lights the airplane can be taken quickly off the runway to the loading platform by the shortest route, even by a pilot unfamiliar with the field. As it rolls into the loading area, it is guided to its parking place by a man with a flashlight. Thus, by the use of signal lighting the plane has been directed and guided from the air safely and directly to its unloading point.

DETAILS OF LIGHTING SYSTEM

Let us consider in more detail the system just described, and with it some other lighting effects not obvious to the casual observer.

Beacon. The first function of airport lighting is the identification of the airport. This is primarily the function of the airport beacon, which is a high-powered light, mounted on a tower or elevated position, so that it may be readily seen from any direction, and flashing alternate white and green beams at five-second intervals. The intensity and direction of these beams is carefully specified, so that a pilot may be sure when he sees the characteristic appearance that he is looking at an airport beacon, and also that the airport may be sure that the beacon is visible and can be identified under any weather conditions for which it is designed.

The most commonly used beacon consists of a 1,000-watt lamp with a *CC*-13 monoplane filament for mounting in an optical system consisting of glass prisms which concentrate the light and direct it out in two beams. One beam is passed through a green filter, so that it produces green light. The whole beacon head is arranged to rotate about a vertical axis at a rate of six revolutions per minute. This beacon, which has a diameter of 36 inches, is normally known as a 36-inch double-end beacon. Another design, known as a 24-inch double-end beacon, consists of two 24-inch drum-type projectors with mirror reflectors, using 500-watt lamps with monoplane filaments. The two projectors are mounted back-to-back on a common yoke and rotated as one unit. A third type of beacon, used by the Army Air Corps, consists of a drum-type lens mounted vertically and carrying on the axis a 1,500-watt lamp with a symmetrical filament. The lamp is oscillated vertically along the axis, and the beam, which extends 360 degrees around the unit, oscillates vertically as the light center moves within the optic. This beacon produces a very rapid flash, between 70 and 80 to the minute, and gives the appearance of an undulating light when seen from any horizontal direction. All beacons are required to be equipped with a spare lamp mounted in a lamp changer which will move it into the optical center and connect it into the circuit upon failure of the operating lamp.

The beacon should be located near the edge of an airport, preferably well away from any normal approaches to the runways, and above any surrounding obstructions. It should not be located on top of the control tower, because of the interference with the operator's vision caused by the flashes when the weather is thick. A beacon is normally operated from sundown to sunup.

Indicating Obstructions. One very important function of lighting on and around an airport is the marking of obstructions. In an airplane traveling at a speed of from 100 to 300 miles per hour, which is roughly from 150 to 450 feet per second, the pilot is not able to see and identify trees, poles, wires, smoke stacks, towers, and other elevated obstructions in time to avoid them, unless they are clearly and distinctively marked. Red lights are used for obstruction markings, so arranged that not only can the light be seen from any direction by an approaching pilot but the shape and extent of the obstruction also are clearly indicated. This necessitates a series of lights to mark a high obstruction such as a radio mast or a smoke stack. It involves the installation of a line of lights marking a clump of trees, a pole line, or any extended obstruction. Obstruction lights are designed to give a maximum intensity at the angles most useful to pilots flying towards the obstruction and generally are installed with red prismatic glass optical globes over the lamps for optical control as well as for color filters. Steadily burning lights normally are used for obstruction lights, as flashing lights do not define the position accurately. Obstruction lights always should be burned from sunset to sunrise.

Lights for Landing Area and Runways. The outlines of the landing area of an airport are marked by means of white boundary lights mounted on approximately 300-

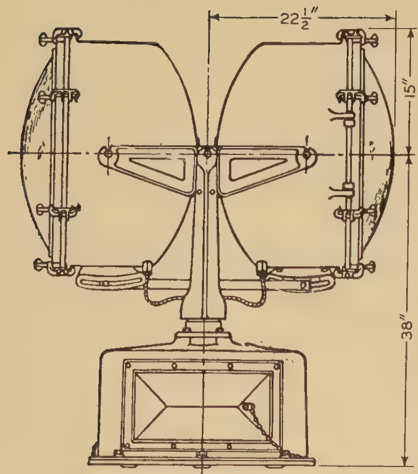

Figure 2. Twenty-four-inch double-end rotating beacon

foot centers. These lights form a line completely around the landing area, and assist the pilot in identifying it. These lines should be as straight as possible, and all corners should be marked by boundary lights. The boundary light consists of a prismatic globe enclosing a 320-lumen series lamp, or a 15 or 25 multiple lamp on top of a sheet-metal cone. The cones are painted international orange, and are designed to give the pilot daytime markings for the limits of the landing area. As the boundary lights are intended to assure the pilot that any part of the area so marked is free from obstruction, it is very important that no obstruction of any kind be allowed within the area. Thus, a pilot using the area within the boundary lights can be sure of not running into floodlight standards, concrete marker posts, or buildings.

The runways, which are prepared surfaces where landings normally should be made, are marked by means of range lights, so called because by ranging up on two similar groups of lights at the two ends of the runway a pilot may be assured of the location and alignment of the runway. Range lights normally consist of groups of lights in the boundary circuit, and are equipped with green globes instead of clear globes. They are arranged in groups opposite the ends of each runway, and are coded in number so that each runway carries a different number of range lights from any other runway. The groups of range lights are also mounted so that they are normal to the axis of the runway even though this makes them sit at any angle to the line of boundary lights of which they form a part.

This sounds like a rather simple arrangement of lights to mark the runways, but it frequently results in considerable complications. In the first place, the range lights should be located not more than a hundred feet or so from the end of the runway surface, so that a pilot may not land on soft ground when he expected paving. This frequently necessitates moving the range lights several hundred feet from the line of the boundary into the landing area to mark a runway that does not extend completely to the boundary. In such a case the range lights are set flush in the ground and supplemented by a similar group where the axis of the runway intersects the line of the boundary. These auxiliary range lights are equipped with yellow globes so that they may be distinguished readily from the green range lights. Their purpose is to afford a pilot taking off towards them a mark or target with which to align himself, as the flush range lights have very little visibility from ground level, and also may be hidden by a slight change of grade.

Another complication frequently arises when two runways have a common end, or when they are so close at the boundary that it is difficult to mount the range light groups and to distinguish between them. For this reason, it is always required that at least one clear boundary light be installed between each pair of groups of range lights when they are close together, even though this involves moving the range lights in far enough on the runways to separate them and to allow room for the clear dividing light. Such range lights are made flush, and in this case auxiliary range lights are again used. Further complication occurs on airports with a large number of runways, where the endeavor to provide a different number of range lights for each runway would require some runways to be equipped with more than six lights. In some such cases where runway contact lights are installed, the range lights are not coded, but are arranged with part of each group on the runway contact circuit and part of it on the boundary light circuit. This arrangement provides a complete block of range lights at each end of the runway which is lighted for use, and leaves only two range lights burning at each end of all the other runways. Another solution which has been tried where parallel runways are installed in four directions is to install two groups of codes on the range lights, mutually at right angles. With such an arrangement three range lights could be used at each end of an east-west runway, and also at each end of a north-south runway, and four lights at each end of a northeast-southwest runway and also a northwest-southeast runway. As the range-light groups are always normal to the axis of the runway, such an arrangement is very unlikely to mislead a pilot.

Where the runways are equipped with contact lights, the necessity of coding the range lights is less important, as the runway contact lights indicate the runway to be used. Even in this case, however, the range lights marking the locations of the ends of the unlighted runways should be lighted all night, for the assistance of pilots who may be forced to land in other directions.

Among the most important lights on an airport are the contact lights used to mark the edges of a runway. These lights are mounted flush in concrete blocks along the edge of the paving, and are spaced about 200 feet apart down both edges of the runway. Care is taken that the individual lights come opposite to each other on the two sides of the runway and are not staggered, as this arrangement assists a pilot in determining the axis

Figure 3. Illuminated tetrahedron wind indicator

of the runway when the weather is thick and he can see only a few lights ahead of him. Contact lights are white along the entire length of the runway, except for the last 1,500 feet, where they are yellow to warn the pilot that he has only 1,500 feet of paving left. As the same arrangement is required in both directions on the runway, the normal method of installation is to use a half filter so that the lights in the 1,500-foot portion show yellow towards the remote end of the runway and white towards the close end. Contact lights are designed with a very accurate optic so that a powerful beam of light is thrown up and down the runway, and relatively little light across the runway or away from it. The lamps used are 320-lumen series lamps, and as high as 1,800 candle power has been obtained at a narrow angle slightly towards the axis of the runway. All runway contact lights are so arranged and controlled that one runway and one only can be lighted at a time. This is to avoid the possibility of having planes try to land or take off on different runways simultaneously. In the case of airports which have parallel runways, arrangements are made so that two parallel runways may be lighted at the same time, but not two runways which are at an angle with each other.

Wind Indicators. The direction of the wind on the landing area is of extreme importance to the pilot coming in for a landing. In order to give him this information, wind tees and wind cones are used. The wind tee consists of a T-shaped rigid body with a long dimension of approximately 20 feet and with the head of the T approximately 12 feet long. This tee is mounted on a pivot and arranged so that it swings with the long dimension in line with the wind and with the head always upwind. The tee is outlined by means of green lights, either incandescent lamps, or gaseous-discharge tubes. A pilot looking at the tee sees a shape similar to that of an airplane heading into the wind. Tees of this nature are now required on all airports where transport operations are conducted.

Some wind tees have been designed so that they may be set in a certain direction from the control tower and arranged with a clutch which releases, in case the wind gets above a predetermined value of say five miles per hour. Some method of indicating the desired landing direction from the control tower which could be used under light winds or no wind conditions would seem desirable, but there is considerable criticism of the idea of using an indicator that at one time shows the wind and at another the tower operator's directions. The wind cone is a smaller device consisting of a 12-foot-long fabric bag or sock suspended with the open end on a pivot so that the sock is free to fill and swing out downwind. These are illuminated either by floodlighting from above or by a lamp and reflector which illuminate the interior of the fabric.

Other types of wind indicators are in use, such as a 36-foot-long tetrahedron-shaped body, which is used by the Army Air Corps, and smoke generators, which produce smoke by means of burning oil, but neither of these has been given wide use as yet. Some experimental developments of electrically operated smoke generators are being tried out at the Washington National Airport. Set flush in the ground, these can be located at various points on the airport, and turned on and off from the control tower. Smoke is one of the most effective wind indicators, providing a good indication of the nature and velocity of the wind, as well as its direction.

Floodlights. Floodlighting is one of the major aids to landing, and one of the more spectacular elements of any airport lighting installation. It is one exception to the general statement that airport lighting is not concerned with illumination, as the floodlights are designed to illuminate a large-enough area on the ground to give a pilot an accurate indication of the ground level and per-

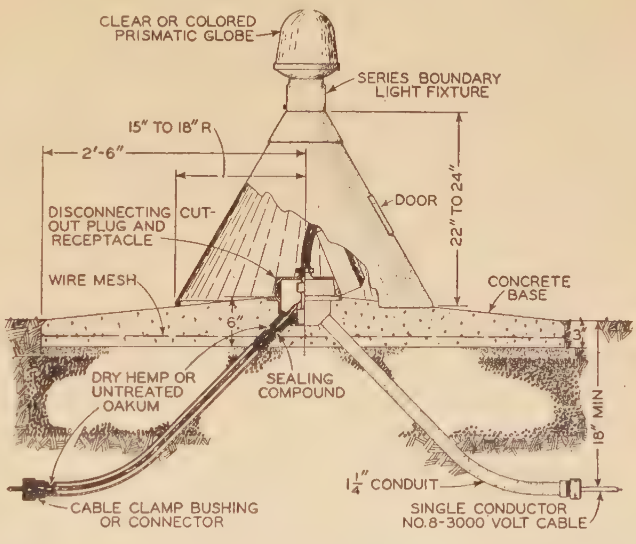

Figure 4. Cone for boundary or range light installed with concrete base

Standard color arrangement for boundary cone is international orange; for range cone, hood is international orange, cone striped in alternate 45-degree segments of white and international orange

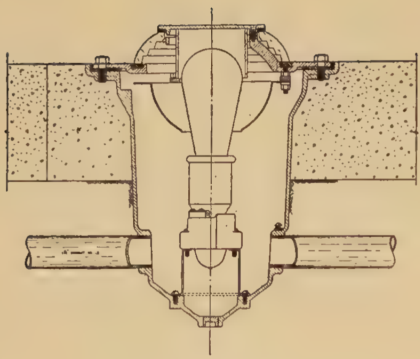

Figure 5. Section through flush-type marker or contact light

spective. Floodlighting is designed to light an area at least 500 feet wide and 3,000 feet long to an intensity of not less than 0.2 foot candle measured on a vertical plane. This area must be lighted either from the rear or from the side in order that a pilot making a landing need not face the glare of the projector units. The floodlights also must be mounted on standards sufficiently low and sufficiently far from the runway to add no material obstruction to the airport. The lighted area should be illuminated as evenly as possible, without sharp changes in light intensity or shadow areas. In general, now, the practice is to install what is known as runway-type floodlighting, in which two floodlight units are mounted at the approach end of the runway and from 100 to 200 feet away from its axis. These units project light directly along the runway from sources immediately behind the pilot, thus causing him no trouble. Other methods of floodlighting involve the illumination of a wide area of ground, either from behind or from the side of the pilot.

Floodlights normally consist of 24-inch projector units, each having a 3,000-watt lamp with a 32-volt monoplane filament, fed from individual 32-volt transformers. Other floodlight units use 1,500-watt lamps with a Fresnel lens which gives accurate control of the light vertically and spreads it horizontally over an angle of 90 degrees. Units of this nature are generally used only in wide-area floodlighting, while the projector type normally are used for runway floodlighting or grouped with distributing lenses to provide wide area coverage.

On the Chicago Municipal Airport, the area will be floodlighted by means of large Fresnel units mounted on 20-foot floodlight houses, one at each corner of the square landing area. The units can be used individually or in pairs. Each consists of two 1,000-millimeter 90-degree lenses and four 500-millimeter 90-degree lenses, all arranged so that their beams overlap. The 90-degree 1,000-millimeter lenses were formed by cutting 180-degree ground Fresnel floodlight lenses in half. This unique lighting should be a very interesting example of the possibilities of general-area floodlighting combined with contact lights along the runways.

Some attention is now being paid to the installation of lighting systems for controlling airplane landings and take-offs and taxiing in after landing. The most elaborate installation of this system is at the Washington National Airport, where 90-foot green arrows formed of gaseous-discharge-tube units are used to indicate to a pilot that he is to land and to show him the correct runway end and direction. A red cross of similar dimensions is used to indicate that landing is not to be made when the runway is lighted up for a take-off. Associated with these landing and take-off signals are lights similar to street traffic signals, designed to control the movements of an airplane taxiing out for a take-off. Airplanes taxiing in after a landing are guided by lights similar to contact lights, installed along the left side of the runway and taxi strip as the airplane moves towards the loading apron. These lights are equipped with blue filters to prevent them from being confused with any other indications.

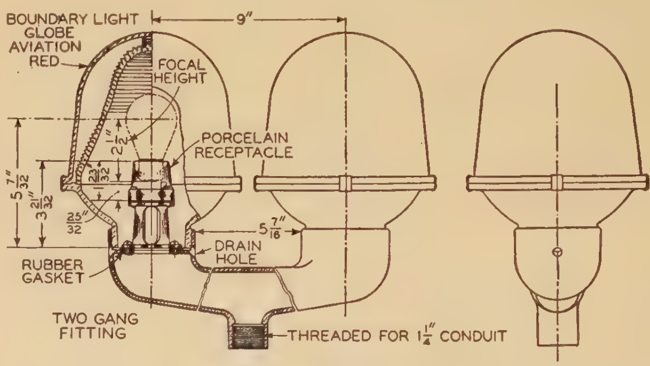

Figure 6. Detail of double multiple obstruction light fixture

The loading area on an airport generally is illuminated by means of Fresnel lighting units mounted on the wall of the building, or on the fence, and employing wide-spread lenses. Such areas should be lighted to approximately four foot-candle intensity, but lights used for this purpose must never be so located that they can project light directly into the air where it will be seen by the pilot. It is also very important that these lights not cause glare to passengers and service men.

Airport lighting circuits are normally series circuits operated from standard 6.6-ampere regulators. Such circuits for the feeding of lights so widely extended have the advantage of producing even brightness in all units. The boundary circuit is normally a number 8 single conductor, generally on a separate regulator. Obstruction lights occurring around the boundary of an airport, and wind tees or wind socks remote from the buildings, are frequently fed from the boundary circuit through series-to-series or series-to-multiple transformers. No other lights, such as floodlights, ever should be connected on the boundary circuit. The runway contact lights normally are arranged with a separate circuit to each runway, and fed from one regulator through a series of short-circuiting relays of which one at a time is opened by the operation of a runway selector. This allows a single regulator to operate a number of different run-

ways, and also prevents more than one runway from being operated at one time. Floodlights normally are fed by means of a radial or loop 2,200-volt feeder that provides primary power for 32-volt transformers mounted at each floodlight unit, or each pair of units. If radial feeders are used, the control usually consists of a remote-controlled oil switch mounted in the distribution center. If a loop feeder or common feeder is used, these remote switches must be mounted in the transformer house, and control circuits must be run to them. Where traffic control is installed, provision is generally made for a 110-volt bus in the transformer houses, in which the individual circuits to the groups of lights are controlled by means of remote contactors. Such lights are generally multiple. The beacon is generally fed by radial feeders which may be either high or low voltage, depending on the distance.

Cables used for airport lighting are generally non-metallic-armored Parkway rubber cable, either rubber-sheathed or made with fibrous armor. In a few of the larger airports, duct lines have been installed for the field circuits, in which case lead-covered cables are used. In all cases runs under the paving should be installed in duct so that cable can be replaced without tearing up the runway surface.

All controls for airport lighting must be centered in the control tower, or in the absence of a control tower at some point convenient for the operation of the field. With increasing multiplicity of controls, it is becoming more important to simplify control operations. The latest control panels have borrowed from theater practice, and are arranging controls that can be preset before they have to be used. Most control panels are provided with a layout of the field in miniature, with switches and pilot lights located on the map to correspond with the position of the lights on the landing area.

Figure 8. Desk-type airport-lighting control panel

The Civil Aeronautics Administration has been experimenting for several years with approach lights, which are lights set in a row outside the airport to mark the approach to a runway, and to assist an airplane to line up with the runway, when the weather is thick and the visibility poor. The first installations consisted of horizontal neon bars, set at right angles to the approach, and spaced 100 feet apart for 1,500 feet. Further experiment has indicated that higher intensities are needed, and longer lines, and also that a double line instead of a single line is an improvement. Experiments in fog are being conducted. The CAA hopes soon to have a satisfactory solution which will enable us safely to lower the present minimum ceiling and visibility limits under which airplanes can be allowed to operate.

The lighting of an airport is not an inconsiderable piece of work. It may involve a matter of 70 to 90 boundary-light units; 150 to 200 contact-light units; 200,000 feet of underground electric feeders, and 8 or more 3,000-watt floodlights. In addition, there are miscellaneous lighting requirements such as beacons, wind indicators, traffic-control lights, taxi-guidance lights, apron floodlighting, obstruction lighting, and all the lighting in administration buildings and hangars.

As of July 1, 1941, there were 690 lighted airports in the United States. By January 1, 1942, lighting was planned or under construction for 276 additional airports.

Airport lighting is not a finished inflexible practice. Developments and improvements are being studied and experiments undertaken constantly. Such studies should be carried out systematically, either by the Civil Aeronautics Administration, or in close collaboration with it, in order that pilots generally may be consulted and notified of any changes or modifications in the systems with which they are familiar.

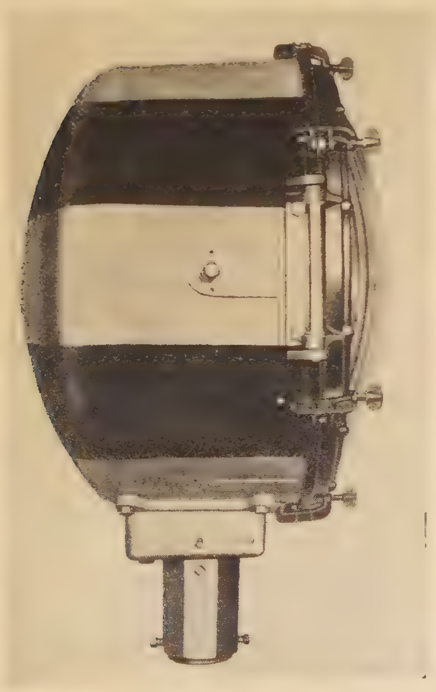

Figure 7. Three-kilowatt drum-type floodlight projector

Spread is varied by using spread-lens fronts

Mobilizing Kilowatts for War

J. A. KRUG

AMERICANS have reason to be proud of this country's industrial might. We have a natural heritage of great factories, raw materials, tools, and skilled man power. This is a country of light and power. No other country of the world has such a combination of natural, human, and mechanized resources. Our economy, however, has been developed to meet peacetime needs. Our men and machines are highly specialized in making automobiles and radios, and other things that improve the standard of living. As yet, we are awkard in making the implements of war. But we must and can make them, and the next year will witness the most difficult and amazing industrial reorganization in history. American industry will be converted, practically overnight, from peacetime mass production to the entirely different job of making the machines of war.

Assured power supply for war industries will require the most detailed and careful planning, and every kilowatt of power must be utilized to maximum advantage, said Mr. Krug in an address at the recent AIEE 1942 winter convention. He outlined what the Government is doing in the planning of power production for war industries and solicited the assistance of all power engineers toward assuring that "power supply will not be the limiting factor in the nation's 'all out' war-production effort."

In this year, already almost a month old, the President has told us that our factories must turn out 60,000 warplanes. In this same year, we must produce 45,000 tanks. In this same year, we must machine and assemble 20,000 precision-built antiaircraft guns, and in this same year we must weld together and equip 8,000,000 tons of merchant shipping.

To these key items of modern warfare will be added a great supply of bombs and ammunition. We also will equip an American army of millions of men. It is no longer possible to disclose detailed figures, but from this bare outline the magnitude of the program is clearly evident.

At the same time this huge productive effort is under way, we will construct and equip hundreds of new plants so that next year's war production may be doubled or trebled. Only two years ago, the country's aluminum production capacity was 360,000,000 pounds, this coming from a number of plants built and expanded over a long period of years. But in this one year, 1942, we will construct aluminum plants with over 1,000,000,000 pounds of annual capacity—an expansion that could not have been dreamed of in 1939. Magnesium is the magic metal of modern war. In 1939 the country had but one magnesium plant with an annual capacity of only 18,000,000 pounds. In this one year we must construct a dozen new magnesium plants with enormous productive capacity.

Everyone now knows that modern warfare is the battle of production. The nation that produces the most aluminum, the most steel, the most copper, the most magnesium, and most of the other strategic materials of war is the nation that ultimately will conquer. War production must be firmly established upon an abundance of these essential raw materials. From that point we can safely build the pyramid of industrial production to obtain the end products of mechanized war. A relatively few basic materials underlie this entire production pyramid; of these the most important—and also the most difficult to obtain in a short space of time—is electric power.

NATION'S POWER RESOURCES

In terms of war needs, peacetime aluminum and magnesium aggregated insignificant amounts. The first surge of war effort swallowed up the nation's entire output; but in other lines, American peacetime industry fortunately had established a good part of the foundation needed for war production. Electric power, for example, has been developed to a point where it is now one of the nation's greatest resources. At the present time, over 51,000,000 kw of effective power capacity is available for service. This enormous peacetime power supply and our policy of carrying comfortable reserves provide a great cushion of power for the expansion of war industries. Furthermore, our policy of providing power supply in abundance has developed an amazing use of power in the home, on farms, in stores, and in peacetime industry. In normal times well over half of the power output of central stations is consumed by commercial and domestic users. Of the remainder, a large amount has been used by industries not essential in modern war.

To this great power reservoir we expect to add in 1942 about 2,200,000 kw of steam and 1,000,000 kw of hydro-

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Address presented at the session on power generation and transmission at the AIEE winter convention, January 26, 1942.

J. A. Krug is chief of the power division, War Production Board, Washington, D. C.

electric power. Unless the ship building program requires an even larger portion of our turbine production than is presently contemplated, power projects already under way will add an additional 2,000,000 kw of steam and 1,000,000 kw of hydroelectric capacity in 1943, and long-range jobs already under construction will bring in an extra 1,250,000 kw in 1944. These figures do not include a number of very important projects only recently authorized.

Except for a few cases, no power capacity that is not already under way can be counted on in 1942 and 1943, as the combined manufacturing capacity of the country for land turbines is now mortgaged well into 1944. The power that we have or that is now under way must be made to meet the requirements of the maximum war effort, with a sufficient balance remaining for essential civilian supply. To the extent that the available power supply does not meet all requirements, it will be necessary to limit the use of electric power to those uses that are most essential. That this will be necessary seems unthinkable in this country where we have long enjoyed an abundant power supply, but it now appears a certainty that stringent limitation measures on civilian use will be required in many strategic war-production areas.

POWER PLANNING FOR WAR PRODUCTION

The question is frequently asked, "How much power will the war effort require?" Unfortunately, no answer can be given to this question. The materials and implements that the armed forces need for the conduct of the war will require all of such materials the country can produce. In other words it is no longer a question of how much is needed. The object must be to produce all we can and as speedily as possible. The production program outlined by the President will require tremendous sacrifices in our civilian economy. It will be necessary to give up everything we can do without. Every possible man-hour, every possible pound of material, and all of our management talent will be necessary in the war effort. The people of the country will have to make the best of it on what is left over. We must make certain that power supply is not the limiting factor in the war effort. The power needs of war industries *will* be provided.

The desired result will not just happen. Assured power supply for war industries will require the most detailed and careful planning. Every kilowatt of power must be utilized to maximum advantage. This can be accomplished only by the most skillful operation and the most complete co-ordination of our power resources and superhuman foresight in the location of new war industries. The long-range economy of the country should be considered, and plant expansion should reflect the pattern that will be most efficient in the economy of future years. But the foremost criterion, and this becomes increasingly apparent with every passing day, is *get the job done and get it done fast.* An ideal industrial plan for the future will avail us nothing if we cannot be here to appreciate it or if we are not in a position to enjoy it!

WAR-PLANNING RESPONSIBILITY OF GOVERNMENT

The planning of war production is the Government's responsibility. Execution of these plans, however, is the responsibility of the engineers of America. Engineers always have played a stellar role in power production, and for that reason power engineers are in an unexcelled position to accept the staggering challenge of the war program. I want to give here a summary of what the Government is doing in planning power production for war industries. I also want to tell of some of the outstanding jobs that are being done in masterly style by power engineers and construction men of the country. We hear almost daily the plea, "Let us know what to expect and we will do whatever is necessary to deliver." This will give an outline of the job.

SCHEDULING TURBINE DELIVERIES

The difficult task of breaking down the war effort into its component parts is well under way. Tremendous war industries already under construction will be greatly expanded—new plants will be added and old plants will be converted to new forms of production. The effects of this new program on power supply are being determined with the greatest practicable accuracy so that the power systems in each section of the country may be forewarned of the situation, and so that turbines and generators now being fabricated can be located where the demands of the war program are most critical. There will be a detailed scheduling of deliveries so that each power system will know within reasonable limits when its new capacity can be expected. Production schedules already have been developed for each major turbine manufacturer for 1942. Early in each quarter a schedule will be developed for the corresponding quarter of the following year. This will give every manufacturer and every power supplier definite information as to deliveries of new generating units for at least the next 12-month period. In addition, tentative schedules are being worked out for several years ahead, which should help to provide an opportunity for planning intelligently for the future.

We already have for each power-supply area in the country a schedule showing the reliable power capacity in relation to the anticipated power loads. The projected loads are being broken down in sufficient detail to permit a realistic comparison of these estimates with the actual results. These figures are under constant scrutiny, and the power-supply picture for each area will be revised from time to time so that it currently reflects all important developments in the war-production program. Each power supplier will be advised of projected war loads for his respective service area. It is already apparent that the power systems serving the important

industrial areas will have to provide power supply substantially in excess of that normally considered as the reliable capacity. Deficiencies must be made up by maximum utilization of reserves and co-ordinated operation of all available facilities, and, where this is insufficient for the purpose, by curtailing nonessential uses.

USE OF MATERIALS MUST BE REDUCED TO MINIMUM

The power branch of the War Production Board has another primary function in addition to the general planning responsibility just outlined: that is to make certain that the power industry and the manufacturers supplying the industry obtain the minimum materials necessary to provide and maintain service to war industries and other loads essential in the nation's civilian economy.

Starting with this basic pattern of anticipated war loads, priority control must assure delivery of equipment and materials to those areas where the need is greatest. In this, we must have the complete co-operation of the industry. It must get along with as little as it possibly can, consistent with maintaining capacity production of all war industries. The country is involved in the supreme test of its history. The days of "silver plated" service are over! It is difficult to backtrack from the service standards established by years of continuous effort, and backtracking will be impossible unless the engineers respond with the same wholehearted effort that we devoted in past years to improving and perfecting service. Power plants, transmission lines, substations, and distribution facilities will be called upon to carry greater loads than they ever carried before.

Management will respond to the test, but management must rely upon its engineers for the knowledge, for the "know how," of what can be done to minimize the use of materials during this period of emergency. It is as bad to risk too much as to risk too little. Stripped blades in a turbine or a burned-out winding in a transformer at a strategic point would be a serious blow to war industry. However, idle spare capacity is directly reflected in reduced scope of the war effort. Engineers as a class have established a reputation for ingenuity, and power engineers are the most ingenious of all. Whatever talent and experience and skill we have must be called upon to meet the test of this emergency. This is a job for operating men and engineers. Government administrators and the executives of the industry can be helpful. But without the vital knowledge of the men who run the power systems, the task will be hopeless.

CO-ORDINATION OF POWER-PRODUCTION FACILITIES

An excellent example of some of the specific things being done to mobilize the power resources of the country is our experience with power pooling. Largely because of the necessity of maintaining capacity aluminum operations during a period of extreme drought, the Southeast experienced in the fall of 1941 one of the most serious power shortages in the history of the country. As early as June, storage reservoirs were drawn down to fall levels, and a continuation of the drought during the fall months reduced the reservoirs of the region to desperately low levels. During this period of emergency, the operating men of the private and public power systems worked together as a single team in a most skillful manner to co-ordinate the facilities of the region to assure maximum power supply. The Government provided the framework for action, but the engineers did the job.

A vast power pool, operating from Chicago, Ill., through Indiana, Ohio, West Virginia, and the southwestern states, pumped power into the area from every available resource. The systems in Georgia, Alabama, and Tennessee alone received over 40,000,000 kilowatt-hours a week—energy vitally needed to maintain industrial production. As a result, not a single production hour was lost by the great aluminum and other essential war industries of the area. It was unnecessary to give orders. Knowing the gravity of the situation, every power system strained generating stations and transmission lines to be of service in the emergency. This experience in co-ordinated operation will be of invaluable assistance in meeting similar situations which are almost certain to develop again not only in that area but also in others.

Another important step in the program of mobilizing power supply is the construction of additional strong interconnecting links between the predominantly steam-electric systems of the Middle West and the predominantly hydroelectric systems of the South. A heavy tie line has just been completed between the Tennessee Valley Authority Norris Dam and Hazard Station of the strong central system of the American Gas and Electric Company. Another major tie line will be completed in late summer of 1942 between the TVA system at Nashville and the interconnected northern power systems at Louisville, Ky. Other interconnecting links are under construction and more will be constructed, interlacing the highly diversified industrial section of western Pennsylvania, Ohio, Indiana, and Illinois. A tie line is already in operation between the publicly owned Santee-Cooper project in South Carolina and the privately owned power systems to the north.

New plants are being rushed to completion throughout this area—both steam and hydroelectric—and in the existing hydroelectric plants of the South, additional machines are being installed as rapidly as possible to provide peaking capacity which will be invaluable in sending peak power throughout the eastern half of the country. These interconnections and new installations will permit the co-ordinated operation of the steam systems of the North and the hydroelectric systems of the South in the manner that will permit the maximum kilowatts from all installations. During dry seasons the steam plants will operate around the clock, sending energy southward during the night hours and on week

ends, so that all available water may be impounded to permit maximum generation during the peak-hour periods when some power may be sent northward. In wet seasons, the hydroelectric plants will pump energy northward, thereby conserving fuel for vital war needs. When the facilities are completed late this summer, this vast power pool will permit the co-ordinated operation of over 10,000,000 kw of generating capacity. The strong transmission ties will permit the transfer of power to those areas where expansion of war industries is most urgently needed.

A similar program is under way west of the Mississippi River in the southwestern states. As a result of a recent decision by the War Production Board, priorities were approved for a combination plan of private- and public-system transmission lines on the condition that the public and private plants would be interconnected and would agree to operate in co-ordination in the manner that will make available maximum power supply. Through an extensive system of transmission facilities, including over 500 miles of new line, the power systems in Texas, Louisiana, Arkansas, Oklahoma, and parts of Missouri, Kansas, and Nebraska will operate together. This great pool will assure capacity production at vital aluminum, magnesium, and ordnance plants now under construction throughout that region.

FREEPORT POWER PLANT

In most areas, power pooling alone has been insufficient to meet all requirements. In some instances desperate measures have been necessary to find an adequate power supply for vital industrial expansion. Near Freeport, Tex., an enormous magnesium plant is being built by the Defense Plant Corporation, a subsidiary of the Reconstruction Finance Corporation, which handles the financing of war industrial expansion. This plant will require over 100,000 kw of reliable power. Sea water will be pumped in over vast beds of oyster shells. The resulting magnesium oxide will be chlorinated and fed into electrolytic cells to be reduced to pure magnesium. Unfortunately, this isolated section of Texas coastline is so far removed from the existing power supply that power cannot be made available even on an interim basis for more than a small portion of this total load. Accordingly, it was necessary to find a way to assemble generation facilities on the spot to take care of the plant's requirements.

At the time this plant was approved, even with *A*-1-*a* priorities, at least two years would have been required for fabricating and installing a complete new generating station. We called upon the ingenuity of some of the leading power engineers in the country to find a way of meeting this apparently hopeless situation. After several weeks of persistent investigation, a plan was developed for assembling a combination of used and partly fabricated new equipment which we are now confident will solve the problem.

From Detroit, Mich., we were able to obtain a 45,000-kw low-pressure turbine, used, but entirely serviceable. This machine was removed from service several years ago in order to make room for progress in the form of a modern high-pressure turbogenerator. From New York, N. Y., we purchased an almost perfect mate for this old servant of the public. This New York machine was actually in service at the time the plan was first developed although normally used as a reserve unit. At the same location we were able to obtain a battery of old low-pressure boilers which can be moved to the new location in Texas. At one of the turbine-manufacturing plants, we discovered a largely fabricated topping unit, undertaken at one time as a stock model, but now almost a perfect answer to our prayer. The used low-pressure boilers and the two low-pressure turbines with some temporary help from the local power system, will permit operation of the plant at capacity as rapidly as the electrolytic-cell rooms can be completed. Installation of the new high-pressure boilers and the topping turbine will increase the over-all efficiency of the installation to a point comparable with a new station of modern design. Taking into account the availability of low-cost natural gas, and the high load factor possible with magnesium operations, the cost of energy will be unbelievably low —equaled by only a few power stations in the country. It is expected that this complete power plant of 125,000 kw will be ready for operation in less than one year, and the first 85,000 kw in eight months.

Of course, it is difficult for many of us who have become accustomed to the luxury of using only new and the most modern equipment to reconcile ourselves to making the best of what we have. To many, this power plant, assembled from a combination of equipment that normally might be considered obsolete, is entirely incomprehensible. But the engineers who conceived the plan believe that the installation will be not only reliable—consistent with the established practice of some of our best power systems—but also one of the most efficient generating stations in the southwestern states.

LAKE CHARLES POWER PLANT

Another large power plant must be constructed at Lake Charles, La., for magnesium production. Anticipating the need for power at this location months ago, orders were placed for five steam-electric turbogenerators with a leading manufacturer, who scheduled delivery for early 1942. Months later, with the outbreak of war, it was discovered that the tremendous pressure of naval work would force the machines entirely out of the 1942 production schedule, regardless of the vital need of the installation for war production. Co-operation from the Navy and diligent effort finally succeeded in restoring three of the machines to the 1942 schedule. Meanwhile, expanding war requirements had necessitated an even larger installation. A careful re-survey of the schedules in each of the turbine-manufacturing plants revealed an

opportunity for scheduling six additional machines with another manufacturer, and within a few days arrangements were consummated to transfer the orders so that the other manufacturer could go ahead at full speed with fabrication, using certain materials previously acquired for machines not essential in the war effort.

Meanwhile, engineers were sent to Texas and Louisiana to work out arrangements for the maximum supply of interim power. In one week of intensive field work, an energetic young engineer from a public power system in the area and another from a private power system working as a team developed a satisfactory answer for interim power supply to supplement the initial steam-plant installation. By this means, it will be possible to provide the total power needs of the new plant as soon as it is ready for operation.

FLOATING POWER PLANTS

Despite the fact that during 1942 over 3,000,000 kw of new land turbines will be installed, it is now clearly apparent that we cannot hope to meet all power requirements, should accidents or unfavorable water conditions prevent the utilization of all reserves. War production is dynamic—changes occur almost daily. In order to meet these changes most effectively, utmost flexibility in power supply is essential. Pooling arrangements will help greatly, but even with these measures, shortages probably will occur in several sections of the country. The location of land power plants must be decided at least two years in advance of completion. Once located, they are firmly tied down to the load centers they were designed to serve.

In order to meet this need for greater flexibility, the Government plans to construct for use at those locations where from time to time war needs are greatest a fleet of at least four floating power plants. These plants, built on barges, will be able to navigate most of the inland waterway system and the Great Lakes. As a result of several months of investigation, a definite plan has been perfected to construct, complete on a single barge, a standard 25,000-kw unit capable of 30,000 kw at high power factor, together with the necessary boilers, fuel tanks, and auxiliaries. These plants will have practically the same efficiency as a land plant; will cost little, if any, more than a land plant; can be towed to almost every important load center in the inland industrial area; and can be readily transferred from one point of emergency to another. For example, if the Southeast should experience another shortage, one or more of these plants could be tied into the interconnected systems at Mobile, Ala., New Orleans, La., Memphis, Tenn., Louisville, Ky., Chattanooga, Tenn., or at many other points. The Southwest can be assisted from Arkansas, Louisiana, or the Texas coast wherever the need is greatest. War industries in Illinois, Indiana, Ohio, and western Pennsylvania can be served from many convenient points on the Ohio and Mississippi River systems; and in most seasons of the year, help can be given in areas as far north as Minnesota and, by utilizing existing transmission networks, as far west as Kansas and Nebraska. These plants will be made available under temporary lease to power systems in shortage areas; where there are competing needs, the War Production Board will determine which are most vital. Even in normal times, floating power plants have considerable merit, as witness the *Jacona* which has long rendered effective service for the New England states. But in wartime emergency, the added flexibility makes each kilowatt of floating power the equivalent of at least two kilowatts tied down at a permanent location.

WAR INDUSTRIES WHERE POWER IS AVAILABLE

As the power situation becomes increasingly stringent, the task of finding power supply for expanding war industries becomes more and more difficult. In appreciation of this situation, we have assigned an experienced power engineer to each major line of war production. It will be his responsibility to make certain that power supply is available when the war plants are ready for operation. For instance, one man, supervising a staff if necessary, will be responsible for the power supply needed for aluminum and another for magnesium, the two war materials that will consume the most power. Steel, chlorine, rubber, trinitrotoluene (TNT), and other munitions all of which use enormous quantities of power, will likewise require special attention. It is necessary now to place new war loads where power supply is still available, and this necessarily means the use of some locations that would not be desirable in a peacetime economy. Aluminum plants will be scattered from New York to California; from Washington to Alabama, Tennessee, and North Carolina. Magnesium plants must be located wherever we can find an adequate power supply and any reasonable proximity of raw materials. Powder plants, Army ordnance, and other lesser war industries will fill in the pattern. The country will speedily become a "beehive" of war production, and industrial centers will spring up where corn fields stood before.

POWER-SUPPLY ALLOCATION

To meet the prospect of power shortage, an orderly and practical plan of power limitation has been largely perfected and is ready for use. The experience in the Southeast will become established procedure where energy is the limitation. A somewhat different approach will be used in those areas where capacity is the controlling factor. Power-limitation programs must be carried out with the greatest of skill if we are to avoid serious dislocation of civilian economy and, in some areas, even war production. We of the War Production Board ask the power engineers to come to our assistance in suggesting ideas and devising improvements that will make the administration of power-limitation orders most effective for the purpose. We have already requested

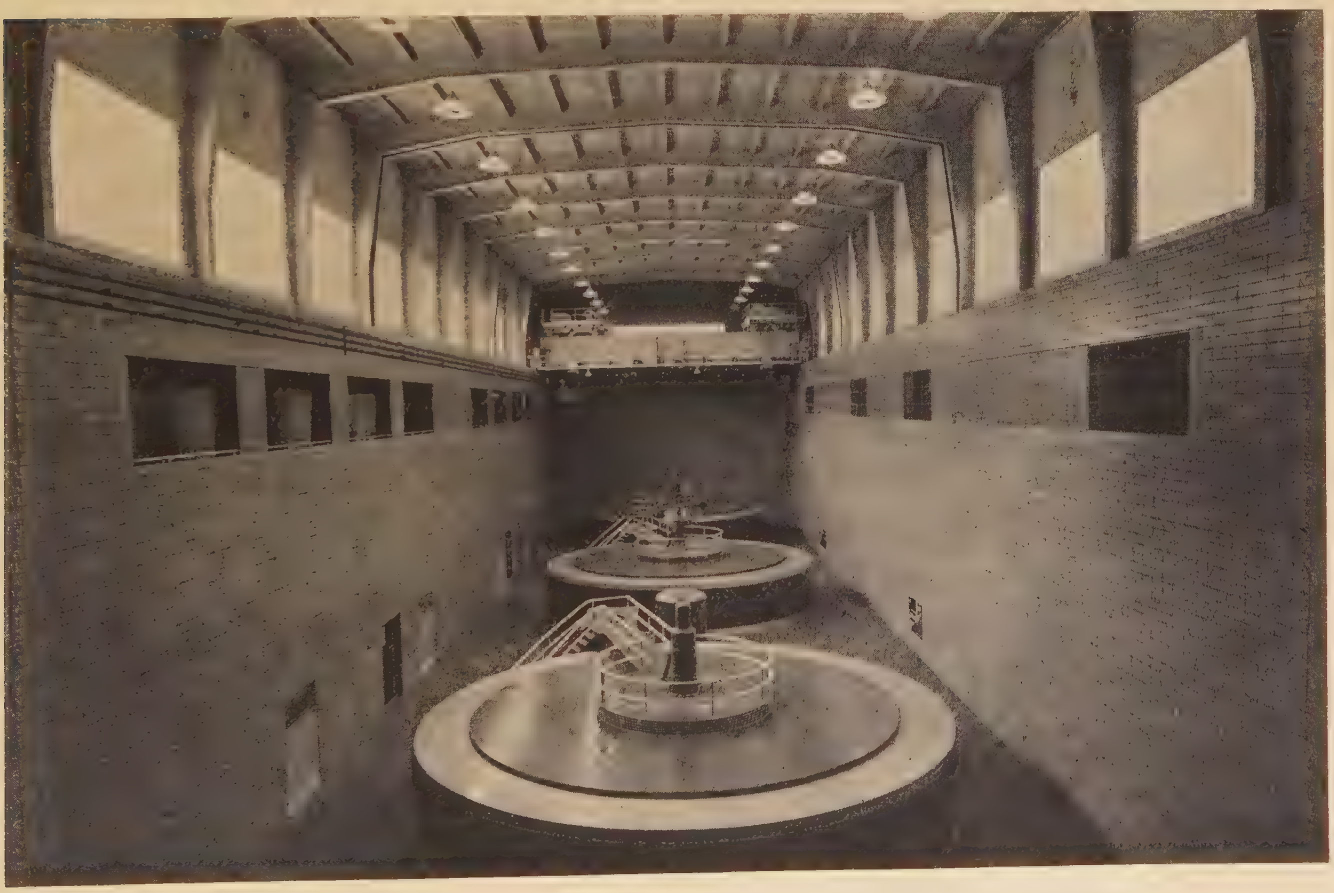
utilities to do everything possible to limit load growth, and it will be necessary soon to go further in discouraging use of power for nonessential purposes. Obviously, the power companies that have not already done so, will have to suspend load-building programs and the promotion of new uses of electricity by domestic and commercial consumers. In this connection, the precautionary measures taken along the Western Seaboard against air-raid attacks show encouraging results. In the San Francisco area alone, peak loads have been reduced about 50,000 kw, or some four or five per cent by such simple expedients as turning off all exposed advertising signs and floodlights, and by dimming store lighting and requesting domestic users to turn off all electric lights when not in use.

"WAR TIME"

"War Time" should be of considerable assistance in conserving power for war industries particularly in metropolitan areas like New York City and Chicago. The companies in these cities estimate that this measure alone should save approximately 100,000 kw in each area during the time of annual peak.

Electricity is too important a public service to encourage or invite curtailment when it is unnecessary, but I am confident that when such measures become urgent, the American public will respond wholeheartedly and the results will be surprising. It should be borne in mind, however, that curtailment and rationing are no cure-all for lack of power capacity. In many areas the curtailable loads—that is, the power used over and above consumption by war industries and essential civilian requirements—is only about ten per cent of the total. In such areas, curtailment should be resorted to only as the final expedient. The remedy of curtailment is no substitute for the remedy of adding plant capacity, of well co-ordinated operation, and the other emergency measures that can be employed. This little buffer between capacity war production and a handicapped war effort should be reserved for those emergencies that are certain to come, regardless of every step we can take under the most diligent planning.

In summary, I merely want to say that assuring power supply for war production is an enormous job. We must have, and I am sure we will get, "all out" assistance from the engineers of America in making good our resolve that power supply will not be the limiting factor in the nation's "all out" war-production effort.



The generator room at the Tennessee Valley Authority Chickamauga Dam, Chattanooga, Tenn.; the three units are rated 30,000 kva each and operate at 75 rpm. An illumination level of 10 foot-candles is provided by 1,000-watt high-bay reflectors; mounting height 61½ feet; spacing 20 feet by 38 feet

The Engineer's Contribution to the War Effort

N. G. SYMONDS

Inventions, substitutions, and application of new means of destruction and defense are regarded by Mr. Symonds, himself an engineer, as the engineer's principal contribution to the war effort. "When the war has been victoriously concluded," he adds, "those talents must be available to lead us into new fields of prosperity in a peace effort that I hope and feel sure will overshadow this tremendous war effort we are now making."

OUR war-production program for 1942 is well known to all. The President asked for 60,000 airplanes, 45,000 tanks, 20,000 antiaircraft guns, 8,000,000 deadweight tons of ships. No one knows better than you the tremendous task it will be to produce these badly needed war materials. Never before has such a program been laid out for any other country, and its achievement will be possible only in the United States.

Let us look at these figures in the light of what we have done. The order is for 60,000 planes to be produced in a single year. It has been 38 years since the Wright Brothers flew the first airplane at Kitty Hawk, N. C. During that time the aircraft industry in the United States made approximately 110,000 airplanes of all kinds, from "puddle jumpers" tied together with baling wire to the 82-ton army bomber that took to the air last fall. So you see that our job is to make in one year substantially more than half the total number of airplanes we made in 38 years. That means that a plane must roll off the production lines of our plants every $8^1/_2$ minutes of every day of 1942. That is a challenging task!

We did not get into serious production of military aircraft in this country until July 1940, and even then it was at the leisurely rate of 560 a month. In January 1941, we produced slightly more than 1,000 planes, and by fall this figure had been doubled. Because of military secrecy I am unable to give later production figures, but you can be assured that they have increased substantially. Those who have been engaged on other projects may be interested to know that military observers report that our best planes are faster, can carry heavier pay loads, and are more reliable than comparable aircraft in any other air force in the world.

As another part of our program we were asked to produce 45,000 tanks. Some will be light tanks weighing $13^1/_2$ tons; some medium tanks weighing 28 tons; and some heavy tanks weighing 58 tons. Although we have been making light tanks for less than two years, we have made them so well that they consistently have outperformed similar tanks on the battlefields of North Africa. The stamina and mechanical reliability built into them by American engineers has contributed considerably to the recent British victories over the Nazi Panzer divisions.

The first medium tank was delivered to the Army in the latter part of April 1941. The first heavy tank was delivered December 8, 1941, the day after the attack on Pearl Harbor. It takes a long time to get ready to make the first tank because these complex fighting machines present engineering problems that have no civilian counterpart. And it takes considerable skill and time to assemble them. Even the light tank weighs four times as much as the average automobile and requires many more man hours to build.

An entire new industry had to be created in order to make tanks, and the fact that it is possible for us to promise to deliver 45,000 during the first year after the industry began operation is proof that the President has confidence in the ability of our management, engineers, and workmen.

We had to create another industry when we went into the production of munitions. A couple of years ago there were only a very few producers of TNT, the powerful explosive needed for shells, bombs, and mines. Complete new plants designed especially for this purpose have been and are being built. Existing facilities could not be used because of the nature of the work and the unusual safety precautions that have to be taken to safeguard plants and human lives. This industry also called upon the brains of engineers to solve those problems and the proof that the assignment was met successfully can be found in the millions of pounds of munitions coming off our production lines today.

Yet another new industry is that making antiaircraft guns. These intricate cannons so vital to the defense of our fighting forces, our industrial centers, and our residential sections, required new production methods, new tools, new techniques. We had some old models, but experience in actual warfare has demonstrated the need for even more powerful weapons. Army ordnance experts gave us specifications for these guns and again our engineers were asked to solve problems that were completely new. Quantity production of some antiaircraft guns began last summer and another model came into production in January 1942. Now that the slow preliminary stages have been passed, we can expect an ever-increasing flow of these vital guns from plants that a

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Essential substance of an address delivered at the general session of the AIEE 1942 winter convention, New York, N. Y., January 28.

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year ago were making automobiles, washing machines, and other machines for our peacetime everyday existence.

In 1941 we had available in our shipyards 170 building ways in 45 yards that could handle steel ships up to 300 feet. During 1941 we launched 1,501,700 tons of merchant ships and 264,255 tons of naval vessels.

The original plan for 1942 called for the construction of 574 ships, aggregating 6,000,000 tons—the greatest program ever attempted by any nation. Now the program, as outlined by the President, is to build during the same period 850 ships, totaling 8,000,000 tons. In order to complete this quota, it may be necessary to add further to our present shipbuilding facilities of 406 ways at 65 yards.

At present we are concentrating on two types of merchant ships, the 427-foot Liberties and the 501-foot C-4's. The Liberties, which are cargo ships, weigh 10,500 tons each, and require the purchase of 65,000 different items, from steel plates to electrical equipment. From the time the keel is laid until delivery represents a span of 105 days. During 1941, 40 such ships were launched. Many more will be built in 1942.

A C-4 weighs between 18,000 and 19,000 tons and is suitable for use as a troop carrier. Contracts are expected soon to be let for the construction of another type of troopship, the PXR, weighing 22,000 tons. These ships are similar to the *America*, a luxury liner currently in use by the Army and now known as the *West Point*.

A comparison will show how challenging our shipbuilding program is. As of September 30, 1941, there were 1,114 ships in our Merchant Marine, each weighing 2,000 gross tons or over, and aggregating a deadweight of 10,114,522 tons. The President has ordered us to build in one year a fleet nearly as large as the one flying the United States flag last year.

Our construction program might well be called the biggest job ever undertaken anywhere. In January 1941 we were nearing the end of a huge camp construction program. The announcement made recently that 32 more infantry divisions would be organized—doubling the size of our Army—means the beginning of an even larger program. The land acquired through lease, purchase, or transfer from other government agencies during the emergency amounts to more than the combined land and water area of the states of Connecticut and New Jersey.

Before we could expect mass production of planes, ships, tanks, or guns we had to have machine tools. The machine-tool industry produced $200,000,000 worth in 1939; in 1942 it may be necessary to produce machine tools in the value of $2,000,000,000—a tenfold increase. That is a program to challenge the ingenuity of every one of us. It is a program that needs the help of every man, woman, and child in America. Those who are already participating will be called on for even more work, and many others who have not yet had the opportunity to share soon will be finding places beside the earlier workers.

The data just given merely show the magnitude of the job we have assigned ourselves. Also these facts clearly prove that this is a mechanized war, and that without engineers the task would be hopeless. When I say "mechanized," I use the word in an all-inclusive sense, for we are so dependent on electric power and electrical engineers today that their importance and need cannot be too greatly stressed.

The message I want to give and emphasize is that in many materials needed for the war, we either have a definite shortage or a prospective shortage that makes the production program previously outlined difficult to attain without severe restrictions or even prohibitions on civilian uses. Engineers can cushion that situation by diligently working to find in less critical materials substitutes for the more critical ones. That is one of our most important tasks. The reason for the restrictive order M-15-B in tires lies in the fact that in 1941 we consumed crude rubber at the rate of 60,000 tons per month. One month over 80,000 tons was used. Actually in prospect today, from all our combined sources of rubber, synthetic as well as crude, is less than 700,000 tons. The accelerated war production means much more rubber for war work, so that we had actually less than a year's supply of crude rubber unless we immediately cut off civilian use of new tires. Many of our joy rides ceased with that order, which is typical of what we may expect. We cut out tires; what else can we do? We can find substitutes for rubber, or we can cut down the rubber content of necessary articles. The railroads, for instance, are aggressively attacking the problem of air-hose connectors to determine whether less rubber and more fabric can be used. That will be a real contribution to rubber conservation. Perhaps electrical men can find a way quickly to use a bare neutral instead of rubber-covered wire. That would save much rubber. Controversial as I know the bare neutral has been for many years, I call attention to it to let it continue to be controversial. I am sure that the electrical engineers of the manufacturing companies, the rubber companies, and the public utilities can find a way to save that very necessary rubber.

Presumably one of the restrictive orders most discussed in the electrical industry is the copper order, M-9-C. Let us review the copper situation briefly. In 1939, out of a total production and importation of 960,000 tons, 66,000 tons were devoted to war work (16,000 for our own use and 50,000 to France, England, and other countries). In 1940 out of a total production and importation of 1,245,000 tons, 175,000 tons were devoted to war work. In 1941, out of 1,400,000 tons, about 600,000 tons were devoted to war work, and it is estimated that out of an available supply of 1,700,000 tons in 1942, 1,250,000 will go to war work. A good deal of that copper goes into shell making; a good deal of it goes into the cable wrapped around boats to save them from dam-

age by mines. Perhaps by the end of 1942 we may be able to use steel in place of brass and copper in shells. If it can be done, it will materially relieve the copper situation, but this year very little copper is available.

Substitutions must be diligently studied and applied. Perhaps with no great tampering with safety, less copper can be used in many designs or applications. That is something that electrical engineers can do, and can study. It may prove possible to use less copper in many instances without in any way jeopardizing the safety of the operations.

Here is an illustration. We have been working with the railroads very carefully on the use of copper. In locomotives, freight and passenger cars, and so forth, some 20,000,000 bearings are in current use. Each one has a copper content—or did have a copper content—of about 18 pounds. Whenever those bearings wear out or have to be replaced, the scrap goes immediately to the melting pot and is recast, and to each scrap bearing only two or three per cent of brass scrap is added to make a new bearing.

The railroads, through their mechanical division and with the help of engineers from outside, particularly those from the companies that make bearings, have found that they can make those bearings with about 67 or 68 per cent of copper instead of the former 77 per cent. That is a real contribution to the saving of copper; it shows what can be done by studying a situation, without any sacrifice of safety.

I think we have all been prone to have a little too much margin of safety. Today we must use what we must use, but we must not use any more than is vitally and absolutely necessary. The engineer's function is to find out what that limit is and approach it as closely as possible, always remembering that we do not want to compromise with safety.

Here is another little story on copper. In 1941, 3,500 tons of copper were used in brass shoe eyelets in the United States. After April 1, they will be made of steel. There will be no more brass eyelets. One of the things that brought about this tremendous use of copper in shoe manufacturing was the buying orgy we went through in 1941. There were 500,000,000 pairs of shoes and slippers manufactured and sold in the United States in 1941. That is about 100,000,000 pairs more than were ever sold before in the United States.

By looking down the list of your own buying, you will find that money was fairly plentiful, you were all faced (or thought you were) with shortages, and you bought and loaded up in such a way that the buying was tremendously accelerated. This helped somewhat to create the shortages that exist today in many lines.

You can go down the list of critical materials and find the same situation as is occurring with copper. Little relief can be expected in 1942, although some relie in some materials may appear in 1943. Many materials, however, will be in the critical class for the duration. Even in regard to steel of which the prospective tonnage for 1942 is 86,000,000, as compared with 67,000,000 in 1940, the situation is disturbing, because of the terrific impact of the war production, plus the substitution of steel for so many uses of copper, aluminum, and other materials. A preliminary allocation of steel shows about 50,000,000 tons immediately assigned to war work, and that tonnage will tend to increase, not decrease. That preliminary setup means that steel for civilian use will be cut from 54,000,000 tons in 1940 to 36,000,000 tons in 1942, notwithstanding the large expansion of the steel industry from 67,000,000 to 86,000,000 tons.

In many domestic uses of these critical materials, we face ultimate shortages also, since such uses are not considered essential. That will be especially true, unfortunately, of all those electrical devices that do so much to lighten the housewife's labor and add so much to the comfort of our homes. But we must always keep before us the inescapable fact that unless we win this war, we may never again enjoy these comforts. For the duration we must sacrifice comforts to insure our liberties.

In the United States, blessed as we have been with no restrictions on our initiative and inventiveness, we have developed a remarkable list of new inventions and improvements to old inventions. As this war goes on, we will develop many new war implements, and through that engineering achievement we will insure an ultimate victory. Some of our foes are primarily imitators in engineering capacities, and the time will come when their channels of information will dry up, and the superb engineering technique of the United States will prove its worth in an unmistakable manner.

To accomplish the objective that we seek in this war effort, therefore, we need the time, the brains, and "will to do" spirit of the engineer even more than of the ordinary citizen. War today, as never before, is a war of motion and not one of position, and it has been made so by engineering developments. Through engineering knowledge we must prosecute this war, and through engineering developments plus production lines that will give the mass quantities to be used, we will win the war. That is the one thing we must keep our sights trained on all the time. Fortunately, we are manned as never before with engineers and engineering schools, and they have developed, through freedom of thought, an initiative and technique that will bring to us an ever-increasing number of vital inventions. The stimulus of saving our liberties will accelerate those inventions. The engineers' contribution to the war effort therefore, will be inventions, substitutions, and application of new means of destruction and defense. When the war has been victoriously concluded, those talents must be available to lead us into new fields of prosperity in a peace effort that I hope and feel sure will overshadow this tremendous war effort we are now making. Engineers are needed now, but they will be needed to a greater extent than ever in the years of peace to come.

John B. Whitehead—1941 Edison Medalist

THE AIEE's highest honor, the Edison Medal, was presented for 1941 to Doctor John Boswell Whitehead, professor of electrical engineering and director of the school of engineering, Johns Hopkins University, Baltimore, Md., "for his contributions in the field of electrical engineering, his pioneering and development in the field of dielectric research, and his achievements in the advancement of engineering education."

Presentation was made at a special session of the 1942 winter convention of the Institute, New York, N. Y., January 28. Chairman N. E. Funk of the Edison Medal committee outlined the history of the medal, which was established by a group of the associates of Thomas A. Edison, to serve "as an honorable incentive to scientists, engineers, and artisans to maintain by their works the high standard of accomplishment" set by Edison himself and which is awarded annually by a committee of the AIEE to a resident of the United States or its dependencies or of the Dominion of Canada "for meritorious achievement in electrical science, electrical engineering, or the electrical arts." The qualifications of the medalist were outlined by AIEE Past President F. Malcolm Farmer. Presentation of the medal and certificate was made by President David C. Prince, who presided at the ceremony.

Essentially full text of Mr. Farmer's address and Doctor Whitehead's response follows.

The 1941 Medalist

F. MALCOLM FARMER, Past President AIEE

IN recognition of most meritorious achievement in the field of electrical engineering by one of our distinguished members, Doctor John Boswell Whitehead, he is awarded the Edison Medal. This Medal was established 38 years ago as a memorial to Thomas Edison whose contributions to the development of the new electrical art did so much for the well-being of our fellow men.

Doctor Whitehead, the 31st recipient of the Medal, is a Virginian descended from the English family of that name who came to this country in 1640. His immediate ancestors have been prominent in southern Virginia, both his grandfather and his great-grandfather having been Mayor of the City of Norfolk. John Whitehead was born in Norfolk August 18, 1872. His formal education was obtained at Johns Hopkins University which he entered in 1889 with the intention of becoming a lawyer. Fortunately for the engineering profession, the scientific atmosphere of Johns Hopkins developed his latent, unrecognized bent, so that after one year he completely abandoned preparing for the law and changed to physics and electrical engineering under Louis Duncan and Henry A. Rowland, those eminent teachers in the early days of the electrical-engineering profession.

After graduating in 1893, Doctor Whitehead spent three years with the Westinghouse Electric and Manufacturing Company where, in connection with the experimental activities on which he was employed, he came into contact with the Westinghouse pioneers of those swiftly moving days, including O. F. Shallenberger, L. B. Stillwell, A. J. Wurts, Albert Schmidt, and George Westinghouse himself. His immediate superior was Charles F. Scott.

After a year spent at Niagara Falls in connection with the installation and operation of the first generators of the Niagara Falls Power Company, Doctor Whitehead returned to Johns Hopkins University for graduate study and obtained his degree of doctor of philosophy in 1903. Then followed a year as research assistant in the National Bureau of Standards and three years as research assistant of the Carnegie Institution of Washington, working in the laboratories of Johns Hopkins. In 1903 he married Miss Mary Ellen Colston of Baltimore, Md. In 1904 he was appointed associate professor of applied electricity and full professor in 1910.

When the school of engineering was established at Johns Hopkins in 1912, Doctor Whitehead was largely responsible for the planning and organization of the new school. He was appointed professor of electrical engineering and, in addition, was made dean of the school of engineering in 1919 and director in 1938. During these years his services as consulting engineer were requisitioned in connection with several important engineering projects, including, on behalf of the City of Baltimore, the Pennsylvania Railroad Company project for transmitting electrical energy at 110 kv through that city. In later years, with the development of his interest in high-voltage insulation, he has had an extensive practice in this field.

During the first World War, Doctor Whitehead was commissioned Major in the Corps of Engineers, United States Army, and was assigned to duty with the Naval Consulting Board in the development of methods for the detection of enemy submarines. In this duty he conducted extensive experiments at the Naval Engineering Experiment Station, Annapolis, Md., continued the work for some months after the close of the War, and made an extensive report of the results to the Navy Department.

The citation refers to Doctor Whitehead's achievements in the advancement of engineering education.

Conspicuous among these is, of course, the school of engineering at Johns Hopkins. From its beginning, Doctor Whitehead has persevered in demanding a high standard for the undergraduate school, one which would be consistent with the reputation of Johns Hopkins in the older professions of law and medicine. He also insisted upon the establishment of regular graduate courses in engineering, which, in the case of electrical engineering, were the first to be offered in the United States. Furthermore, Doctor Whitehead has himself consistently set a high standard as an engineering teacher by requiring hard work and thorough mastery of fundamentals by his students, and by setting an example of enthusiastic prosecution of experimental research not only to his graduate students but to his faculty.

Doctor Whitehead will probably agree, however, that the field in which he has contributed most to the advancement of electrical engineering is that of research. He has never lost the inspiration for this, the early incentive for which was received in the atmosphere of scientific investigation that penetrated even into the undergraduate departments of Johns Hopkins University. In addition to inspiring others, he has for years been a tireless research worker.

Some idea of the extent of Doctor Whitehead's research work, in addition to his educational duties, is indicated by the fact that of about 100 articles on scientific and technical subjects which he has published, about three quarters are reports of the results of research projects. The subjects cover a wide range, such as the "Magnetic Effect of Electric Displacement," which is the subject of his first paper, published in 1903; the performance of synchronous commutators; the vibration of telephone diaphragms; submarine detection in an a-c field (a Naval Consulting Board assignment in the previous World War); and numerous studies of corona discharges, including the development of an instrument for the direct measurement of high potentials which embodied that phenomenon. He is best known, however, for his extensive research work on electrical insulation, the results of which have added greatly to our knowledge of the characteristics of certain important classes. He has the ability to plan and execute systematically programs designed to develop that fundamental knowledge which is so essential for intelligent improvement in, and efficient application of, our insulating materials. Not only is he an indefatigable worker, but he follows closely the work of others, both here and abroad, thus being enabled to analyze critically the results of his own work in the light of the current dielectric theories. As a consequence, Doctor Whitehead is a widely recognized authority on electrical insulation.

In addition to his own activity in an academic atmosphere, Doctor Whitehead has done much to stimulate fundamental research in industry on electrical insulation. Many of the graduate students who assisted him in his work were inspired to embark on research careers in industry. He was responsible for the organization of an annual conference of both university and industrial workers dealing with insulation and was its active leader for many years. This annual conference has become a largely attended and highly regarded meeting for the interchange of the results of insulation research projects.

Doctor Whitehead is a member or fellow of many scientific and engineering organizations including the National Academy of Sciences, the American Physical Society, the American Association for the Advancement of Science, and the Engineering Division of the National Research Council. He is an honorary member of the French Society of Electrical Engineers and a former president of our own Institute in which he has rendered much service in various official capacities, including the chairmanship for 19 years of the Baltimore Section which he founded in 1904. Many honors have been awarded him, including the Edward Longstreth Medal and the Elliott Cresson Gold Medal of the Franklin Institute; the triennial prize of the Institute Elektrotechnique Montefiore, Liege, Belgium, in 1922 and also in 1925; the Medal of Honor, University of Nancy, France, in 1927, and the Medal of Meritorious Achievement of the Advertising Club of Baltimore in 1934. He was selected as exchange professor to the universities of France in 1926–27.

After this brief and necessarily somewhat limited review, it is with the greatest pleasure that I present a fellow engineer of many years' acquaintance; a man who has attained eminence in our profession through hard work, clear and orderly thinking, and studious habits; a man of whom the great Johns Hopkins University and the engineering profession may well be proud; a man whom I am proud to call my friend, John B. Whitehead.

A Debt I Owe

J. B. WHITEHEAD, 1941 Edison Medalist

SOME years ago, in a happier day for France, it was my privilege to be associated over a brief period with Professor Paul Janet, distinguished director of L'Ecole Supérieure d'Electricité in Paris. In his office, stretching well across one wall, was a row of portrait photographs, only one or two of which could I identify. To my question as to who they were, Janet replied: "Les hommes qui ont influencé ma vie" (Men who have influenced my life). It seemed to me a very graceful way of paying constant tribute to men he had admired, revered, and who had had an influence on his life.

This little incident has recalled itself frequently in the past few weeks, in my constant speculation as to how I could have seemed worthy of the high honor conferred upon me tonight. The equally constant answer to all my questions is the debt I owe to the many men

(and a few women) who have inspired, encouraged, and aided me in all stages of my professional life.

I cannot show you such a series of portraits as Janet's, nor would there be the time to recall all those whose example and influence I recognize with admiration, affection, and respect. On the other hand, there are a few men who have been so intimately associated with my early scientific aspirations and training that I should feel this occasion quite incomplete if I did not emphasize my indebtedness to them.

Wide World

Doctor J. B. Whitehead receives Edison Medal from President D. C. Prince

I propose, therefore, to present a few recollections of my early professional years. The names I have in mind may appear only incidentally; many of them are famous names; nearly all of them have participated in the activities of this Institute. Some of them I have known intimately, and some only distantly, but it seems to me that all of them, and indeed many others, have contributed something to the accomplishments referred to in the generous citation accompanying the award.

In 1889 a 17-year-old freshman entered the Johns Hopkins University aiming to study law. Physics in his first year brought him into the then new physical laboratory, and in retrospect he recalls the sensation of being immediately plunged into an atmosphere of active scientific research. Henry A. Rowland was then in the full flight of his famous researches on the solar spectrum, the mechanical equivalent of heat, the magnetic effect of a moving electric charge, and many others. Although little sensible at that time of the real significance of these great things, the atmosphere, and many excursions, often unauthorized, into remote rooms and corners of the laboratory did something to our freshman, and the next year found him enrolled in one of the earliest courses in electrical engineering in this country, started in 1887 under Rowland and Professor Louis Duncan. Duncan, a classmate of Frank J. Sprague at Annapolis, had come to Johns Hopkins for further study under Rowland, and soon revealed a brilliant and productive research ability, particularly in the applied electrical field. This field at that early date was wide open, and Duncan's enthusiasm was so great that at the earliest possible moment he assigned problems in research even to second- and third-year undergraduate students. A contemporary issue of the Johns Hopkins University *Circular* describes a number of these student researches, one of them by our freshman and a classmate, on magnetic-field distortion in continuous-current motors. Many members of the Institute will remember Duncan as its president from 1895 to 1897, and as a pioneering engineer, but it has always seemed to me that he would have made an equally brilliant record in research.

Leaving Johns Hopkins for a while, our now budding engineer entered the shops of the Westinghouse company and soon found himself in the laboratory under Charles F. Scott, and again in a stimulating atmosphere of experimental study. Scott had completed his early studies in polyphase transmission and was uncovering in experiment the importance of cooling surfaces and open construction in transformers. O. B. Shallenberger was developing his meters. A. J. Wurts was studying lightning and bringing out new arresters. C. E. Skinner was already improving both materials and methods for high-voltage insulation. The limit at that time was 10,000 volts, but in a neighboring lot across Garrison Alley, and so at safe distance, a transformer for the unheard-of rating of 200 kva and 25,000 volts was being tested. Ralph D. Mershon, fresh from his work on the Telluride transmission, was at this time working on the development of a-c motors. More intimate contact with him and his restless inventive spirit was reserved for our young engineer for later years, when Mershon continued his independent studies of the high-voltage corona at Niagara, and still later in joint services to the Naval Consulting Board in the first World War.

There followed a year at Niagara on the operating staff of the first three 5,000-kva generators of the new power development, bringing with it many valuable contacts with large-scale engineering. Outstanding in memory are the night shifts in the power house, when with little to do our young engineer ploughed through every page and formula of Charles P. Steinmetz' "Alternating Current Phenomena," which had just appeared. A by-product of this study of—to my mind—the greatest of all the works of that great electrical theorist, was the noting of many typographical errors in the first edition. These were sent to Steinmetz, and were the beginning of a most stimulating correspondence and acquaintance.

But the University and its laboratories had never ceased to call, and 1898 found our young engineer returned to Johns Hopkins as instructor in electrical engineering. Duncan was soon to leave for the Spanish War, and there followed a precious three years' close association with Rowland before his untimely death in

1901, working under him for the doctor's degree, and assisting him in the laboratory.

Rowland, the distinguished physicist, was also a first-class engineer. He was consultant, along with George Forbes, E. E. N. Mascart, Galileo Ferraris, Lord Kelvin, and others, to the Niagara Falls Power Company in reaching decision as to the best type of generator for the Niagara project. I well remember the various plans as shown and described by Rowland in one of the meetings of his Seminary. He invented several new types of measuring instrument, including the sensitive a-c electrodynamometer, and was the first to apply this important instrument to the measurement of dielectric loss. Recently I have read in the *Transactions* of the Institute for 1889 one of his papers on the nature of electrical conductivity; and mighty good reading it is too, even in the light of the wider knowledge of today.

At this time, however, Rowland was chiefly occupied with the development of his alternating octoplex printing telegraph. My association with him in this work gives me the opportunity to recount a series of widely separated and apparently unrelated incidents, which in retrospect, however, are seen to hang together as fleeting glimpses of the rapidly developing art of long-distance telegraphy and telephony.

In the early 1890's Oliver Heaviside's remarkable series of papers on electromagnetic theory appeared in the London *Electrician.* Rowland emphasized their importance in his lectures, and noted particularly the influence of distributed capacitance on long-distance communication lines, and the necessity for the introduction of magnetic reactance at intervals as a corrective measure. Already during his work on the printing telegraph he had designed and built reactance coils of different values for this purpose.

Later on in 1899 the printing telegraph was already working between Rome and Naples, and it was proposed to exhibit it as between London and Paris during the Exposition of 1900. I well recall the day when in the laboratory we had set up an artificial reproduction of the London–Paris line, which, of course, included a section of heavy distributed capacitance represented by the cable under the English Channel. This caused serious distortion of the successive letter signals and naturally interfered with the reliability of message reception. In trying various corrective measures Rowland remarked to me: "Whitehead, if we could only get two of my reactance coils inserted in that cable under the Channel, we would not be having this trouble."

Michael Pupin's great paper computing the values and spacing of reactance coils for different types of circuit and as related to permissible limits of attenuation and distortion appeared in 1900. Pupin was a friend of Rowland and particularly of J. S. Ames, who succeeded Rowland as Professor of Physics at Johns Hopkins after Rowland's death in 1901. He made a number of visits to Baltimore at about this time, lecturing in the University and in public, on his practical system for greatly extending long-distance telegraphic and telephonic communication. In 1905 I spent a term at the Swiss National Polytechnic Institute in Zürich, studying under W. Weber, a crusty but highly efficient old German professor of electrical engineering. While being shown through the laboratory on my arrival, I noticed what appeared to be an artificial communication line, made up of units of series resistance and parallel capacitance; I commented on it, remarking that I had seen one something like it in Pupin's laboratory at Columbia University. Whereupon Weber replied: "Ah, Pupin. Yes, he came here and he saw my artificial line which was the first one ever built. He stayed and he worked with it, and then he went back to America and took out a patent for work done on my line. That is the way all you Americans make money!" or words to that effect. I said nothing at the time, and reserved judgment until I could hear another side of the story.

A good opportunity for this came several years later when one evening Pupin, R. D. Mershon, Cary T. Hutchinson, Leo T. Baekeland, and several other distinguished scientists and engineers were assembled, as was their custom, at the University Club in New York, for discussion of scientific problems arising in World War I, and upon which all of them were more or less deeply engaged. It seemed to me a good time to tell Pupin of my experience with Weber, which I did forthwith. He was much interested, threw back his head, laughed heartily, and said: "Yes, I was delighted to find an artificial line in Weber's laboratory. I had not been able to afford one myself. Of course I worked with it. The trouble with Weber was that after he had built his line, he did not know what to do with it."

But my time grows short and I must not prolong too far the reminiscences of my contacts with these great men. My recollections of them are among the clearest of my earlier life and from the example of each of them I am sure that I derived something which has made better whatever effort I have undertaken in later years.

I am also keenly aware that in these later years I have contracted similar obligations for assistance, co-operation, encouragement, and support from many colleagues, fellow research workers, and friends. The mere list of their names would be too long for this occasion. Many of them are still active in co-operation, support, and friendship. Some of them are here this evening. To each and every one I take this opportunity to express my lively appreciation and obligation.

Mr. President, in expressing my deep sense of the great honor paid to me in the award of the Edison Medal, I can only add that somewhere in the back of my mind there is the ridiculous fancy that the names of all those I have mentioned and many others somehow also should be inscribed upon the medal, in due recognition of the part they have played in whatever I have done which seems to make me worthy of the award.

Integration in the Complex Plane

K. O. FRIEDRICHS

This article originally was presented as the second in a group of five lectures before the Basic Science Group of the AIEE New York Section as a symposium on "Advanced Mathematics as Applied to Electrical Engineering." The first, which appeared in the February issue, dealt with Heaviside's direct operational calculus. In the past 25 years the Heaviside method of solving differential equations, to a large extent, has been replaced by solutions involving functional transformations. Such transformations require some knowledge of integration in the complex plane, a long-established field of mathematics. This article is then a mathematical prerequisite for those on Laplacian transforms, Fourier integrals, and traveling waves on transmission lines, which will follow.

PAUL C. CROMWELL, Chairman, Symposium Committee

(College of Engineering, New York University, New York, N. Y.)

IN the first article of this series Professor J. B. Russell[1] gave a survey of Heaviside's direct operational calculus. This direct calculus has proved to be very successful. It may be applied to a large class of problems concerning differential equations of transients. Nevertheless there has been much criticism about the validity of the operational method. The theory of complex integration, the topic of the present article, is the main tool which permits us to put Heaviside's calculus on a solid basis. Aside from this justification, however, complex integration is an indispensable tool for any advanced mathematical treatment of transient problems, transmission problems, or related problems in electrical theory.

The application of functions of complex variables has one inherent feature not present in other fields of mathematics, as for example, differential equations. When differential equations are treated mathematically, their physical interpretation can be carried along directly: differential equations can be interpreted immediately as equations of motion or equilibrium, and the operations performed can in general be given a physical meaning. This is quite different with functions of complex variables. Here an extended abstract mathematical development without immediate physical interpretation is necessary before the applications can be begun. It is the purpose of the present article to give a brief account of this mathematical development. Extensive applications will be found in the following articles of the series.

The theory of complex functions is based on the theory of complex numbers, but goes far beyond those parts of the theory of complex numbers that are applied to the treatment of steady-state alternating currents.

A complex number $z=x+jy$ is an entity that is given by two real numbers, the "real part" x, and the "imaginary part" y. It is possible to apply to complex numbers the customary algebraic rules concerning addition and multiplication, provided the additional rule $j^2=-1$ is observed. Mathematicians have used complex numbers for centuries with a very bad conscience. This bad conscience disappeared only after the geometrical interpretation of complex numbers had been discovered.

The complex number $z=x+jy$ is represented by the point (x, y) in the (x, y)-plane and all operations with complex numbers can be given a geometrical interpretation. This is illustrated in Figure 1. Complex numbers are also conveniently expressed by the polar co-ordinates (r, θ) of the point (x, y), that is, in the form

$$z=r \cos \theta+jr \sin \theta=r(\cos \theta+j \sin \theta) \qquad (1)$$

The main concern in the present field is not with numbers but with functions, which assign to variable complex numbers z other complex numbers w, also denoted by $w=w(z)$. Such functions can be formed by using addition, multiplication, or division, as, for example

$$w=z^2 \qquad w=1/z$$

or

$$w=c_0+c_1z+c_2z^2$$

where c_0, c_1, c_2 are complex constants. The function $w=1/z$ has an important property: it is not defined for $z=0$, and when one considers points z approaching zero, the points $w=1/z$ go off to infinity. The function $w=1/z$ is said to have a singularity at $z=0$. The function $w=1/(z-c)$, where c may be any complex number, has a singularity at the point $z=c$. This notion of singularity will prove to be of fundamental importance.

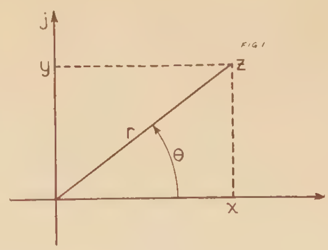

Figure 1

A complex function can be split into a real and an imaginary part: $w=u+jv$. For example, $w=z^2$ splits into $w=(x^2-y^2)+j(2xy)$; it combines the real functions

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x^2-y^2 and $2xy$ of two real variables into a single much simpler expression.

Addition, multiplication, and division yield the so-called "rational functions." There are however other important functions, for example the exponential function. The exponential function is defined in such a way that the formal rules which hold for the real exponential function are preserved. To do this the function ϵ^z must be defined by

$$\epsilon^z=\epsilon^{x+jy}=\epsilon^x(\cos y+j\sin y)=\epsilon^x\cos y+j\epsilon^x\sin y \tag{2}$$

where ϵ is the base of the natural logarithm. The function ϵ^z and its properties are valuable mathematical tools for the theory of steady-state alternating currents.

The inverse of the real exponential function ϵ^x is the logarithm; therefore the inverse of the complex exponential function is also termed logarithm: $w=\log z$. It is obtained from the relation $z=\epsilon^w=\epsilon^{u+jv}=\epsilon^u(\cos v+j\sin v)$.

Comparison with equation 1 yields $r=\epsilon^u$ and $\theta=v$, whence $u=\log r$, $v=\theta$; thus

$$\log z=\log r+j\theta \tag{3}$$

where r and θ are the polar co-ordinates of z. The function $\log z$ has a very important property: When one lets the point z move around the origin $z=0$ and return to its starting point, the value of $\log z$ does not return to its original value, since the angle θ increases by $360°=2\pi$. Therefore the function $\log z$ is augmented by $2\pi j$ when z moves around the origin and returns to its starting point. The function $\log z$ is thus not a single-valued function of z.

Complex differentiation can be performed in exactly the same way as in the calculus of real functions: the same rules hold. Thus

$$\left.\begin{array}{l} dz^2/dz=2z,\ d\epsilon^z/dz=\epsilon^z \\ d\log z/dz=z^{-1} \end{array}\right\} \tag{4}$$

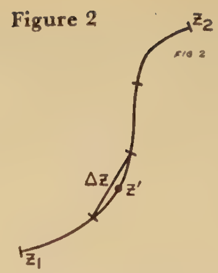
$$dz^{-m}/dz=-mz^{-m-1} \tag{4^m}$$

It is not intended to explain here precisely the meaning of differentiation for complex functions, although this is an important point, since the proper definition of differentiation is the basis for a proper definition of what are called "analytic" functions of a complex variable.

Whereas the integral of a real function is extended over an interval, a complex integral is extended over curves in the z-plane. In Figure 2 let C be a curve connecting the points z_1 and z_2, $w(z)$ an analytic function (one for which a continuous derivative exists in the region considered). Then C is divided into small segments, the value $w(z')$ at some point z' of each segment is multiplied by the difference Δz of the end-points of this segment. The limit of the resulting sum $\Sigma w(z')\Delta z$ for finer and finer subdivisions is then the integral

$$\int_C w(z)dz=\int_{z_1}^{z_2} w(z)dz$$

Figure 2



It is hardly ever necessary to carry out this limiting process explicitly. The situation is like that encountered in the real calculus, where integrals can be evaluated by using the results of differentiations, as a consequence of the fundamental theorem of the integral calculus. This theorem can be formulated as follows: When $w(x)$ is the derivative of a function $f(x)$, that is,

$$w(x)=df(x)/dx$$

the integral of $w(x)$ can be evaluated by the formula

$$\int_{x_1}^{x_2} w(x)dx=[f(x)]_{x_1}^{x_2}$$

where the bracket is an abbreviation for the difference $f(x_2)-f(x_1)$. A like theorem holds for complex integration: Whenever it happens that the complex function $w(z)$ is the derivative of another complex function $f(z)$, that is,

$$w(z)=df(z)/dz$$

the integral of $w(z)$ can be evaluated by the formula

$$\int_{z_1}^{z_2} w(z)dz=[f(z)]_{z_1}^{z_2} \tag{5}$$

This theorem is certainly not surprising, and could easily be proved.

Consider the examples:

$$\left.\begin{array}{l} \displaystyle\int_{z_1}^{z_2} zdz=\frac{1}{2}[z^2]_{z_1}^{z_2}=\frac{1}{2}z_2^2-\frac{1}{2}z_1^2 \\ \displaystyle\int_{z_1}^{z_2} \epsilon^{kz}dz=k^{-1}[\epsilon^{kz}]_{z_1}^{z_2}=k^{-1}(\epsilon^{kz_2}-\epsilon^{kz_1}) \\ \displaystyle\int_{z_1}^{z_2} z^{-(m+1)}dz=-m^{-1}[z^{-m}]_{z_1}^{z_2},\ m=1,2,\ldots \end{array}\right\} \tag{6^m}$$

These evaluations have been obtained without specifying the curve connecting the end points z_1 and z_2. This leads to the most important property of complex integrals: The value of the complex integral

$$\int_{z_1}^{z_2} w(z)dz$$

depends only on the end points of the curve and is independent of the connecting curve. If the two points were connected differently, the value of the integral would be the same, as may be seen immediately from equation 5. This result seems obvious, but it has been derived here only under the assumption that a function $f(z)$ exists such that

$$df(z)/dz=w(z).$$

The decisive point is that it is possible to prove the independence without assuming the existence of an "in-

definite integral." This is very important because the main results of complex integration are obtained in just such cases, where an indefinite integral is not known. The theorem then reads: The integral

$$\int_{z_1}^{z_2} w(z)dz$$

has the same value for two curves connecting z_1 and z_2, provided that the two curves do not enclose a singularity of $w(z)$. This integral theorem of Cauchy is the basis of the application of complex integration.

The integral theorem can be formulated in another way. Let C in Figure 3 be a closed curve which does not enclose a singularity of $w(z)$. C can be considered as a curve which begins at a certain point and leads back to the same point, that is, for which the end point z_2 coincides with the initial point, z_1. Another way of connecting a point with itself consists in simply staying there. For such a degenerate curve consisting of a point, the integral is evidently zero. Hence Cauchy's integral theorem yields the result that the value of the integral from z_1 to z_2 is also zero when it is taken along the closed curve C. In the customary notation this result is written thus:

Figure 3

$$\oint_C w(z)dz = 0 \tag{7}$$

for any closed curve C not enclosing a singularity of $w(z)$. This statement can be shown to be equivalent to the formulation of Cauchy's theorem already given.

The restriction that the closed curve C should not enclose a singularity is very essential. Let us evaluate the integral

$$\oint_C z^{-1}dz,$$

where the curve is a circle with the center at the origin $z=0$ as shown in Figure 4. The integrand $w(z)=z^{-1}$ certainly has a singularity at the origin. We obtain the value of this integral from equations 3, 4, and 5. As we let the point z_2 travel from z_1 along a circle $|z|=$ const., until it again meets the point z_1, we notice that the polar angle θ_2 of the point z_2 does not return to its original value θ_1, but that its end value is $\theta_1+2\pi$. That is, although the initial and the end point are the same, initial and end value of the polar angle differ by $2\pi=360°$. Hence we obtain value $2\pi j$ for our integral:

$$\oint_{|z|=\text{const.}} z^{-1}dz = 2\pi j. \tag{8}$$

This result would be in contradiction to equation 7 if the restriction had not been made that the curve C enclose no singularity of the function $w(z)$.

Let the function $w(z)$ have a singularity at the point $z=z_0$; let C be a curve which encloses z_0 but no other singular point of $w(z)$. Then the expression

$$(2\pi j)^{-1}\oint_C w(z)dz = (\text{Res } w)_{z_0}$$

is called "the residue" of the function $w(z)$ at the point $z=z_0$. Thus the residue of $w(z)=z^{-1}$ at the point $z=0$ has the value 1; that is,

$$(\text{Res } z^{-1})_0 = 1. \tag{9}$$

Similarly one has

$$(\text{Res } [z-c]^{-1})_c = 1, \tag{9a}$$

as can be seen from equation 9 or equation 8 after introducing $z-c$ as a new variable.

Residues need not differ from zero. Consider, for example, the function $w(z)=z^{-(m+1)}$, $m=1, 2, \ldots$, which has a singularity at $z=0$. According to equation 4^m, the indefinite integral of $z^{-(m+1)}$ is $-m^{-1}z^{-m}$; this is a single-valued function, which returns to its original value after traveling around the origin. Therefore we have from equation 6^m, for $m=1, 2, \ldots$,

$$\oint_C z^{-(m+1)}dz = 0, \tag{8^m}$$

$$(\text{Res } z^{-(m+1)})_0 = 0, \tag{9^m}$$

and similarly,

$$(\text{Res } [z-c]^{-(m+1)})_c = 0. \tag{9a^m}$$

Cauchy's integral theorem permits us to evaluate complex integrals by deforming the path of integration. By virtue of the theorem the value of the integral remains unchanged when the path of integration is so deformed that no singularity of the integrand is crossed. The end points of the path must be kept fixed. If the curve is closed, initial and end point may also be deformed. Let O in Figure 5 be the initial and end point on the original closed curve C, and let O' be the initial and end point on the deformed closed curve C'. Then the integral from O to O along C is the same as that over a path connecting O with O', leading along C' back to O', and then returning to O. Since the integrals along the connecting pieces from O to O' and from O' to O cancel out, the integral over C' is the same as that over C.

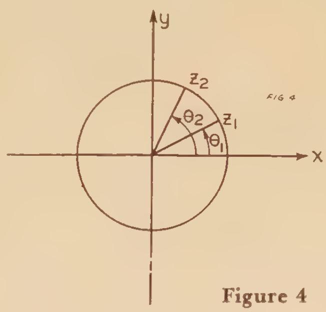


Figure 4

When a singular point is encountered in deforming a path of integration, it may be avoided in the following manner. Let the curve C in Figure 6 be so deformed into the curve C' that the singular

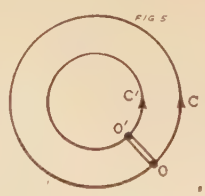


Figure 5

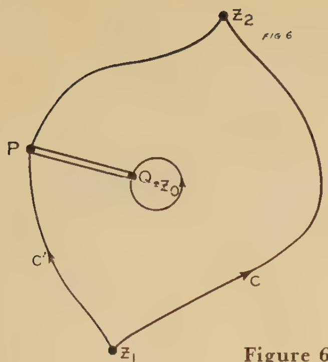


Figure 6

point $z=z_0$ has been crossed from the right to the left, and no other singular point is crossed. Let P be a point on C', Q a point near $z=z_0$. Then the integral over C is the same as that over a path leading along C' to P, from there to Q around $z=z_0$, back from Q to P, and then along the remainder of C'. Since the integrals over the two pieces connecting P with Q cancel each other, we find

$$\int_C w(z)dz = 2\pi j(\text{Res } w)_{z_0} + \int_{C'} w(z)dz. \tag{10}$$

This formula gave rise to the term "residue."

The main purpose in deforming a path of integration is to replace the original path by another which permits an easier evaluation of the integral. How this may be achieved can be seen from

Theorem 1: Let the function $w(z)$ possess the singular points $z=z_1, z_2, \ldots, z_n$ within the closed curve C. Then

$$(2\pi j)^{-1} \oint_C w(z)dz = \sum_{\nu=1}^{n} (\text{Res } w)_{z_\nu}, \tag{11}$$

(where the right-hand member is the sum of the residues of all singular points enclosed by C).

This theorem can be derived in an obvious manner by the successive use of equation 10. For its application consider the integral

$$(2\pi j)^{-1} \oint_C [3z^{-1} - 4(z+4)^{-1}]dz$$

where C (in Figure 8) is a closed curve surrounding the points $z=0$ and $z=-4$. The residue of the integrand at $z=0$ is clearly $(\text{Res } 3z^{-1})_0 = 3(\text{Res } z^{-1})_0 = 3$; the residue at $z=-4$ is $-4(\text{Res}[z+4]^{-1})_{-4} = -4$. Hence the value of the preceding expression is $3-4=-1$.

In the preceding example the evaluation of the residues was obvious. In general, certain considerations are necessary to this end. Consider, for example, the residue

$$(\text{Res } [z+4]^{-1}z^{-1})_0 = (2\pi j)^{-1} \oint_C (z+4)^{-1}z^{-1}dz,$$

where the curve C encloses the point $z=0$ but not $z=-4$. The factor $(z+4)^{-1}$ is regular at $z=0$; its value at $z=0$ is $(4)^{-1}$; the difference $(z+4)^{-1}z^{-1} - 4^{-1}z^{-1}$ is easily shown to be regular at $z=0$; hence

$$\oint_C [(z+4)^{-1}z^{-1} - 4^{-1}z^{-1}]dz = 0, \text{ or}$$

$$(\text{Res } [z+4]^{-1}z^{-1})_0 = 4^{-1}(\text{Res } z^{-1})_0 = 1/4.$$

In a similar way one obtains

$$(\text{Res } [z+4]^{-1}z^{-1})_{-4} = (-4)^{-1}(\text{Res } [z+4]^{-1})_{-4} = -1/4.$$

From general considerations of this kind one may derive

Theorem 2: Let $w(z) = k(z)(z-z_0)^{-1}$, where $k(z)$ is regular at $z=z_0$ (or at least approaches a finite limit $k(z_0)$ as $z \to z_0$); then

$$[\text{Res } w(z)]_{z_0} = k(z_0) \tag{12}$$

In the preceding example we had $k(z) = (z+4)^{-1}$ with $z_0=0$ and $k(z)=z^{-1}$ with $z_0=-4$.

A different form of the preceding theorem, which is very useful for applications is

Theorem 3: Let $w(z) = f(z)/g(z)$, where $f(z)$ and $g(z)$ are regular at $z=z_0$, and $g(z_0)=0$, $g'(z_0) \neq 0$, with $g' = dg/dz$. Then

$$[\text{Res } f(z)/g(z)]_{z_0} = f(z_0)/g'(z_0). \tag{13}$$

This follows from equation 12 if one sets

$$k(z) = f(z)/g(z)(z-z_0)^{-1} = f(z)/[g(z)-g(z_0)](z-z_0)^{-1};$$

the last quotient evidently tends to $f(z_0)/g'(z_0)$ as $z \to z_0$.

For an example let us take

$$Q = (2\pi j)^{-1} \oint_C 3(z+5)^{-1}(z+2)^{-1}(z-p)^{-1}dz,$$

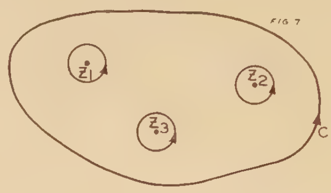


Figure 7

where p is any complex number. The path C is to enclose the three singular points $z=-5, -2, p$. By virtue of equation 11, the expression Q equals the sum of the residues of the integrand at these three points. The residues are evaluated from equation 12. Hence

$$Q = (p+5)^{-1} - (p+2)^{-1} + 3(p+5)^{-1}(p+2)^{-1}.$$

The expression Q can also be evaluated differently, by

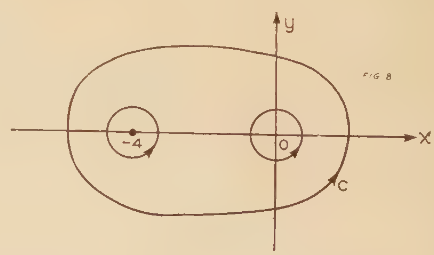


Figure 8

deforming the path C toward infinity, say by letting C be a circle $|z|=r$ with $r \to \infty$. The integrand tends to approach zero like r^3 while the length of the path C is $2\pi r$; for this reason the integral approaches zero and, since its value is independent of the path, it is equal to zero. Thus we have obtained the formula

$$3(p+5)^{-1}(p+2)^{-1} = -(p+5)^{-1} + (p+2)^{-1},$$

an example of a resolution into partial fractions.

A generalization of theorem 3 that is useful in circuit applications is

Theorem 4: If m is a positive integer and if the limit

$$\lim_{z \to z_0} [(z-z_0)^m w(z)]$$

exists and differs from zero, then w is said to have a pole of order m at $z=z_0$ and

$$(\text{Res } w)_{z_0} = \lim_{z \to z_0} \left\{ \frac{1}{(m-1)!} \frac{d^{m-1}}{dz^{m-1}} [(z-z_0)^m w(z)] \right\}$$

Deformation of the path of integration toward infinity frequently yields striking results. The most important case for future applications is

$$(2\pi j)^{-1} \int_{Br} \epsilon^{zt} z^{-1} dz \tag{14}$$

where the path Br, sometimes called the Bromwich path, is any line parallel to the imaginary axis and to the right of it, that is, $x=x_0>0$ from $y=-\infty$ to $y=\infty$.

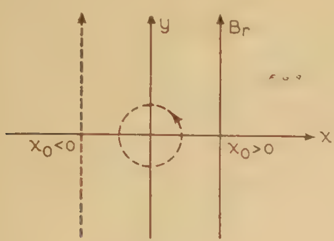


Figure 9

The value of integral 14 along two lines $x=x_0$ and $x=x_1$ is the same, provided x_0 and x_1 are on the same side of zero. This important property, which holds for a wide class of integrals along Br, is essentially a consequence of Cauchy's integral theorem.

One sees from Cauchy's theorem that the path $x=x_0$ may be deformed as shown in Figure 10 into the path described as follows: it runs along $x=x_0$ from $y=-\infty$ to $y=-b$, crosses over to $x=x_1$ along $y=-b$, runs along $x=x_1$ from $y=-b$ to $y=b$, crosses back to $x=x_0$ along $y=b$ and finally proceeds along $x=x_0$ from $y=b$ to $y=\infty$. When now b is increased indefinitely, the integrals over the connecting pieces along $y=-b$ and $y=b$ approach zero, since the integrand $\epsilon^{zt}z^{-1}$ approaches zero if $|y|=b\to\infty$. Thus it is shown that integral 14 along $x=x_0$ equals that along $x=x_1$ if x_0 and x_1 are on the same side of zero.

This fact now makes evaluation of integral 14 very simple. If t is negative, one shifts the path Br parallel to itself toward $+\infty$; that is, one lets $x_0\to\infty$. The integrand $\epsilon^{zt}z^{-1}=\epsilon^{x_0t}\epsilon^{iyt}z^{-1}$ approaches zero very rapidly as $x_0\to\infty$, when t is negative. Consequently, integral 14 approaches zero as $x_0\to\infty$. (To see this one may transform integral 14 through integration by parts into

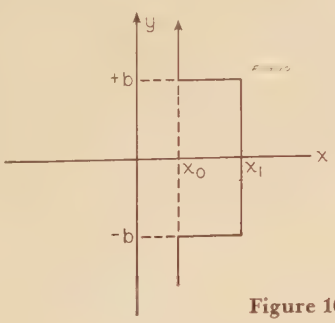


Figure 10

$$(2\pi jt)^{-1} \int_{Br} \epsilon^{zt} z^{-2} dz$$

this expression can be estimated by

$$|2\pi t|^{-1} \epsilon^{x_0 t} \int_{Br} (x_0^2+y^2)^{-1} dy = |2tx_0|^{-1} \epsilon^{x_0}$$

which approaches zero as $x_0\to\infty$, if $t<0$.) That integral 14 is independent of x_0 for $x_0>0$, and on the other hand approaches zero for $x_0\to\infty$ forces one to the conclusion that it has the value zero.

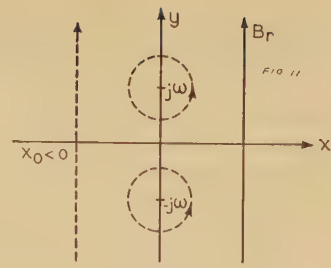


Figure 11

If t is positive, one will naturally try to shift the path Br toward $x_0=-\infty$ since $\epsilon^{x_0t}\to 0$ as $x_0\to-\infty$ if $t>0$. This displacement, however, is hampered by the singularity at $z=0$. As one crosses this point, a residue remains; that is

$$(2\pi j)^{-1} \int_{x_0>0} \epsilon^{zt} z^{-1} dz = (2\pi j)^{-1} \int_{x_0<0} \epsilon^{zt} z^{-1} dz + (\text{Res } \epsilon^{zt} z^{-1})_0$$

The integral along $x_0<0$ can now be shifted toward $x_0=-\infty$ and be shown to be zero as before. The value of the residue is found from equation 12 to be 1. In this way one obtains

$$(2\pi j)^{-1} \int_{Br} \epsilon^{zt} z^{-1} dz = 1(t) \tag{15}$$

where the function $1(t)$ [also denoted by $H(t)$] is the "unit function" defined by $1(t)=1$ for $t>0$, $1(t)=0$ for $t<0$. The integral representation of the unit function by equation 15 is the basis of the application of complex integration to operational calculus.

Another integral of similar type is

$$(2\pi j)^{-1} \int_{Br} \epsilon^{zt} (z^2+\omega^2)^{-1} dz$$

For $t<0$, the value is zero, which is shown as before by deforming the path toward $x_0\to\infty$. Shifting toward $x_0=-\infty$ for $t>0$ is hampered only by the singularities at $z=j\omega$ and $z=-j\omega$. The residues at these points are evaluated from equation 13:

$$(\text{Res } \epsilon^{zt}(z^2+\omega^2)^{-1})_{j\omega} = \epsilon^{j\omega t}/2j\omega$$

$$(\text{Res } \epsilon^{zt}(z^2+\omega^2)^{-1})_{-j\omega} = \epsilon^{-j\omega t}/-2j\omega$$

Hence

$$(2\pi j)^{-1} \int_{Br} \epsilon^{zt}(z^2+\omega^2)^{-1} dz = (2j\omega)^{-1}(\epsilon^{j\omega t}-\epsilon^{-j\omega t})1(t) = \omega^{-1}\sin \omega t 1(t) \tag{16}$$

The great power inherent in complex integration, to some extent illustrated by the preceding examples, will become clear in the subsequent articles of this series, where many practical applications will be presented.

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Third AIEE Wartime Convention Emphasizes War Needs

The influence of the war, into which the United States was so suddenly plunged on December 7, 1941, was reflected in many ways at the AIEE 1942 winter convention held January 26–30 in New York, N. Y. This was the Institute's third wartime national convention, the two previous ones having been held February 15–16, 1918, and June 26–28, 1918. Attendance was the lowest it has been since 1937, a total of 1,331 having registered. Average attendance at sessions also was somewhat lower than in previous recent years. Attendance details are given in accompanying tabulations.

Many of the sessions and conferences were devoted to wartime subjects. These included: a symposium on distribution systems in wartime (all five of the papers presented at this session are included in the *Transactions* Section of this issue); conference on the use of substitute materials in the communication industries; conference on national-defense lighting; conference on air transportation at which attendance was restricted to members of the Institute who are citizens of the United States; and a conference on the subject "How Can the Institute Sections and Members Be Most Helpful in the Present Emergency?"

Several of the special events of the convention also were related to the war and the war-production program, including the following three addresses: "Power for War Needs," by J. A. Krug, chief of the power branch, War Production Board, Washington, D. C.; "The Engineer's Contribution to the War Effort," by N. G. Symonds, consultant on co-ordination of conservation orders, War Production Board, Washington, D. C.; and "A Peace Worth Fighting For," by Doctor William E. Wickenden, president, Case School of Applied Science, Cleveland, Ohio. All three addresses are published elsewhere in this issue.

TECHNICAL SESSIONS AND CONFERENCES

A total of 20 technical sessions, at which more than 70 papers were presented, and 6 conferences was held during the convention, extending from Monday through Friday. Attendance statistics are given in an accompanying tabulation. As most of the papers and discussions presented at the sessions will be published in the 1942 AIEE *Transactions*, no detailed reports are given here. However, brief reports on several of the sessions, as they have been made available, are included elsewhere in this issue. Reports on most of the conferences also are included.

Analysis of Registration at Recent Winter Conventions

District	1939	1940	1941	1942
New York City and foreign (3)	752	743	523	545
Middle Eastern (2)	404	412	946	349
North Eastern (1)	287	332	276	237
Great Lakes (5)	76	76	122	93
Southern (4)	16	22	27	68
Canada (10)	28	20	12	11
South West (7)	37	10	2	9
North Central (6)	4	2	8	7
Pacific (8)	4	6	12	6
North West (9)	2	3	3	2
Totals	1,610	1,626	1,931	1,331

GENERAL SESSION

An address by N. G. Symonds, consultant on co-ordination of conservation orders, War Production Board, Washington, D. C., on "The Engineer's Contribution to the War Effort" comprised the principal feature of the general session held January 28. Mr. Symonds discussed at some length the tremendous war-production program that has been undertaken in the United States and the sacrifices it will require. He stated that the engineer's contribution "will mean inventions, substitutions, and applications of new means of destruction and defense; and when the war has been victoriously concluded, those talents must be available to lead us into new fields of prosperity in a peace effort that I hope, and feel sure will overshadow this tremendous war effort we are now making." Essential substance of his address appears elsewhere in this issue.

Immediately preceding Mr. Symonds' address, the Alfred Noble prize for 1941 was presented to an Institute member, Robert F. Hays, Jr., for his paper "Development of the Glow Switch." Presentation was made on behalf of the Board of Award by James K. Finch, Renwick professor of civil engineering, Columbia University, New York, N. Y. (See item elsewhere in this section.)

The session was opened by AIEE President D. C. Prince who presided throughout. Also, at the general session, P. L. Alger, chairman AIEE technical program committee, outlined a new course of action recently adopted by that committee to make the Institute's technical programs of greater service to the country during wartime (see item elsewhere in this section).

EDISON MEDAL PRESENTED

At a special session of the convention held Wednesday evening, January 28, the 1941 Edison Medal, highest award of the AIEE, was presented to Past President John B. Whitehead, professor of electrical engineering and director of the school of engineering, The Johns Hopkins University, Baltimore, Md. Doctor Whitehead received the medal for "his contributions in the field of dielectric research, and his achievements in the advancement of engineering education."

Chairman N. E. Funk of the Edison Medal committee outlined the history of the medal, after which Past President F. Malcolm Farmer outlined the medalist's achievements. AIEE President D. C. Prince, who presided throughout the ceremony, made the presentation, after which Doctor Whitehead paid tribute to those who had inspired, encouraged, and aided him in all stages of his professional life. Full text of Mr. Farmer's and Doctor Whitehead's addresses appears elsewhere in this issue.

Following the medal presentation was an address by William E. Wickenden, president of the Case School of Applied Science, Cleveland, Ohio, who spoke on the subject "A Peace Worth Fighting For." Doctor Wickenden urged that, in addition to putting forth the tremendous effort required to win the war, we look ahead to the peace that must follow and plan to avoid the mistakes made at the conclusion of the first world war. He urged that we plan now to make it a "peace worth fighting for." Full text of his address appears elsewhere in this issue.

ENTERTAINMENT

Entertainment high lights of the convention as usual were the dinner-dance–buffet supper held Thursday evening, January 29, at the Waldorf-Astoria Hotel and attended by a total of 445 members and

Analysis of Registration at 1942 Winter Convention

Classification	Dist. 3	Dist. 1	Dist. 2	Dist. 4	Dist. 5	Dist. 6	Dist. 7	Dist. 8	Dist. 9	Dist. 10	Foreign	Totals
Members	455	198	275	48	74	4	9	5	2	10		1,080
Men guests	51	22	46	5	12					1	4	141
Women guests	31	16	20	13	7	1		1				89
Students	8	1	8	2		2						21
Totals	545	237	349	68	93	7	9	6	2	11	4	1,331

guests; and the smoker held Tuesday evening, January 27, in the Hotel Commodore, which was attended by some 1,400. The dinner-dance program included: dinner from 7:00 to 9:00 p.m.; president's reception from 9:00 to 9:30 p.m.; dancing from 9:30 p.m. to 2:00 a.m.; and supper from midnight to 2:00 a.m. The smoker program included a dinner and floor show as usual, preceded by a cocktail hour.

For the women guests a special program of entertainment and trips to near-by points of interest had been arranged. High light of this program was the luncheon-bridge-costume review held Tuesday afternoon, January 27, at the Hotel Pierre. The costume review included a showing of defense costumes. Total attendance at this affair was 65. Other events on the women's entertainment program included radio-broadcasts, inspection of Red Hook housing development and slum clearance project, and a trip to the Bache Museum.

Attendance at Winter Convention Sessions and Conferences—1940–42

	1940		1941		1942	
	Number Sessions	Attendance	Number Sessions	Attendance	Number Sessions	Attendance
Monday a.m.	3	364	2	295	3	215
Monday p.m.	2	449	2	290	3	465
Tuesday a.m.	3	632	4	380	4	374
Tuesday p.m.	2	320	3	260	3	348
Wednesday a.m.	4	615	1	360	1	150
Wednesday p.m.	3	244	4	510	3	316
Thursday a.m.	3	465	3	350	2	217
Thursday p.m.	4	387	3	525	2	377
Friday a.m.			3	205	3	230
Friday p.m.			2	100	3	251
Totals	24	3,476	*27	*3,275	27	2,943
Average per session		144.8		121.3		109.0
Ratio of attendance		1.33		1.11		1
Convention registration		1,626		1,931		1,312

* Does not include Friday evening session, which was joint with the American Society for Metals.

NO INSPECTION TRIPS

Because of the war, there were no scheduled inspection trips during the convention. This left the last day of the convention, which in previous years has been devoted entirely to such trips, free for technical sessions and conferences.

DIRECTORS AND COMMITTEES MEET

Meetings of the AIEE board of directors and of the following committees and groups were held during winter-convention week: Lamme Medal; national nominating; Sections; membership; planning and co-ordination; Institute policy; finance; safety; education; electrochemistry and electrometallurgy; land transportation; protective devices (executive group); electrical machinery; basic sciences; communication; Student Branch counselors; subcommittee on voltage transients in arc-furnace circuits; joint committee on oil circuit breakers; subcommittee on distribution-type protector tubes; joint committee on bushing standardization; standards co-ordinating committees 1 and 4; subcommittee on stationary contact surfaces, of standards co-ordinating committee 7; subcommittee on temperature measurement; joint subcommittee on electronics; subcommittee on correlation of system-grounding impedance; subcommittee on test of measurements of resistance; subcommittee on mercury-arc rectifiers; and subcommittee on insulating oils and cable saturants.

Reports of the meetings of the board of directors and of the national nominating committee are given elsewhere in this section. Such reports of other committee meetings as have been made available also are included.

WINTER CONVENTION COMMITTEES

The committee responsible for this year's convention consisted of:

D. A. Quarles, *chairman;* J. W. Barker, T. F. Barton, G. E. Dean, E. E. Dorting, J. F. Fairman, L. C. Miller, D. H. Moore, J. H. Pilkington, C. S. Purnell, and W. W. Truran.

The general committee was assisted by the following three subcommittees:

Dinner-Dance: S. B. Graham, *chairman;* E. S. Banghart, J. G. Derse, E. T. Farish, F. G. Guldi, L. F. Hickernell, J. L. Holton, G. J. Lowell, O. W. Manz, Thomas Maxwell, Ernst Ohnell, P. W. Spence, F. Van Olinda, William Van Tassell.

Smoker: J. E. McCormack, *chairman;* A. J. Cooper,

Ben Fasman photo

Seen at the AIEE winter convention smoker (left to right around table): President D. C. Prince, Vice-President J. E. Housley Past President P. M. Lincoln, National Secretary H. H. Henline, Junior Past President R. W. Sorensen, Director Mark Eldredge Vice-President E. S. Lee, and Presidential nominee H. S. Osborne

Attendance at Special Features of Recent Winter Conventions

Feature	1939	1940	1941	1942
Total registration	1,610	1,626	1,931	1,331
Smoker	1,264	1,466	1,420	1,400
Dinner-dance	527	538	730	445
Inspection trips	1,167	1,700	1,055	0*

* No trips scheduled because of war.

A. B. Covey, T. C. Duncan, A. A. Emlen, William Jordan, E. G. D. Paterson, T. D. Reimers, W. H. Rodgers, H. B. Snow, E. F. Thrall, W. R. Van Steenburgh, M. L. Waring, E. E. Wolff.

Women's Entertainment: Mrs. G. S. Rose, *chairman;* Mrs. T. F. Barton, Mrs. L. B. Bonnett, Mrs. R. F. Brower, Mrs. H. C. Dean, Mrs. A. F. Dixon, Mrs. J. F. Fairman, Mrs. C. W. Franklin, Mrs. R. A. Jones, Mrs. H. S. Osborne, Mrs. W. R. Smith, Mrs. George Sutherland.

Board of Directors Meets

At the regular meeting of the AIEE board of directors, held at Institute headquarters, New York, N. Y., January 29, 1942, approval was given to a recommendation of the joint committee on postwar planning that the Sections of the Founder Societies be requested to co-operate in such planning by (1) organizing joint committees to study plans for maintaining full employment, and (2) searching for qualified leaders for national and regional organizations.

The board also approved a recommendation by the joint committee of the Founder Societies on inter-American engineering co-operation that each society appoint a committee to co-operate with the Inter-American Development Commission, whenever requested, to give engineering advice in connection with its projects or other services.

Upon invitation of the Institution of Engineers (India), arrangements with that institution for the exchange of membership privileges for visiting members were authorized.

Upon recommendation of the committee on Student Branches, authorization was given for the establishment of a Student Branch of the Institute at the University of Delaware, Newark, Del.

Upon recommendation of the committee on education, the following resolution was adopted:

RESOLVED that the board of directors of the AIEE wishes to express itself as favoring the continuance of undergraduate electrical engineering curricula without curtailment of academic time or content.

Rules governing the use of headquarters rooms for meetings were adopted as recommended by the headquarters committee.

Chairman Beardsley of the Institute policy committee presented progress reports on various matters that had been referred to the committee.

Actions relating to Institute meetings were taken as follows: A resolution was adopted, specifying that the 1942 annual meeting of the Institute shall be held in Chicago, Ill., on June 22. The executive committee, however, was authorized to change the date to some other day during the summer convention week, upon receipt of request from the technical program committee by April 1, in case developments should make a change desirable. The dates, October 14–16, 1942, were approved for the previously authorized Middle Eastern District meeting to be held in Pittsburgh, Pa. A schedule of national conventions and District meetings for the year 1943, recommended by the committee on planning and co-ordination, was adopted as follows:

Winter convention, New York, N. Y., January 25–29

Summer convention, Cleveland, Ohio, June 21–25

Pacific Coast convention, about September 1 (location to receive further consideration by the Districts concerned)

North Eastern District meeting, Providence, R. I., in the spring

Southern District meeting, Virginia

South West District meeting, Kansas City, Mo., in the spring

Appointment of W. F. Davidson as an Institute representative on the sectional committee *C*-8 on insulated wires and cables was reported and confirmed.

T. H. Morgan and I. Melville Stein were reappointed AIEE representatives on the Council of the American Association for the Advancement of Science for the year 1942.

Upon recommendation of the Sections committee and the District officers concerned, all territory in Districts 2 and 6 not previously a part of any Section was assigned to existing Sections as follows:

Middle Eastern District (2)

To the Columbus Section: Meigs, Callia, and Lawrence counties in Ohio.

To the Lehigh Valley Section: Cumberland, Dauphin, Juniata, Lebanon, Mifflin, and Perry counties in Pennsylvania.

To the Maryland Section: Somerset and Worcester counties in Maryland.

To the Pittsburgh Section: Bedford, Franklin, Fulton, and Huntington counties in Pennsylvania; Barbour, Doddridge, Lewis, Preston, Taylor, Tucker, Tyler, and Upshur counties in West Virginia; and Garrett county in Maryland.

To the Washington Section: Grant and Hardy counties in West Virginia.

To the West Virginia Section: Braxton, Gilmer, Pendleton, Pleasants, Pocahontas, Randolf, Ritchie, and Webster counties in West Virginia.

North Central District (6)

To the Denver Section: All counties in Colorado; Sheridan, Garden, Deuel, and all counties to the west of these, in Nebraska; Perkins, Meade, Pennington, Washington, Shannon, and all counties to the west of these, in South Dakota; all counties in Wyoming.

To the Nebraska Section: Cherry, Grant, Arthur, Keith, Perkins, Chase, Dundy, and all counties to the east of these, in Nebraska; all counties in North Dakota; Carson, Ziebach, Haakon, Jackson, Washabaugh, Bennett, and all counties to the east of these, in South Dakota.

Other actions by the board included the following:

Minutes were approved of the meeting of the board of directors held October 24, 1941, and of a meeting of the executive committee on November 12, 1941.

Executive committee actions on applications were reported and confirmed, as follows: As of November 21, 1941—4 applicants transferred to the grade of Fellow; 38 transferred to the grade of Member; 43 elected to the grade of Associate; 677 Students enrolled. As of December 22, 1941—2 applicants transferred to the grade of Fellow; 15 transferred and 25 elected to the grade of Member; 74 elected to the grade of Associate; 385 Students enrolled.

Reports were presented and approved of meetings of the board of examiners held November 27 and December 18, 1941, and January 22, 1942. Upon recommendation of the board of examiners, the following actions were taken: 2 applicants were transferred to the grade of Fellow; 19 were transferred and 11 were elected to the grade of Member; 98 were elected to the grade of Associate; 219 Students were enrolled.

Monthly expenditures were reported by the finance committee, and approved by the board, as follows: \$27,690.45 in November; \$28,009.12 in December; and \$21,386.76 in January.

Those present were: *President*—David C. Prince, Schenectady, N. Y.

Past Presidents—F. Malcolm Farmer, New York, N. Y.; R. W. Sorensen, Pasadena, Calif.

Vice-Presidents—J. W. Barker, New York, N. Y.; J. L. Hamilton, St. Louis, Mo.; N. S. Hibshman, Bethlehem, Pa.; J. Elmer Housley, Alcoa, Tenn.; Arthur L. Jones, Denver, Colo.; Everett S. Lee, Schenectady, N. Y.; A. LeRoy Taylor, Salt Lake City, Utah.

Directors—T. F. Barton and H. S. Osborne, New York, N. Y.; M. S. Coover, Ames, Iowa; Mark Eldredge, Washington, D. C.; R. E. Hellmund, East Pittsburgh, Pa.; T. G. LeClair, Chicago, Ill.; Fred R. Maxwell, Jr., Pensacola, Fla.; W. B. Morton, Philadelphia, Pa.; R. G. Warner, New Haven, Conn.

National Treasurer—W. I. Slichter, Schenectady, N. Y.

National Secretary—H. H. Henline, New York, N. Y.

Official Candidates Announced for 1942

The official ticket of candidates for the Institute offices that will become vacant August 1, 1942, was selected by the national nominating committee at its meeting held in New York, N. Y., January 27, 1942. This committee, in accordance with the constitution and bylaws, consists of 15 members, one selected by the executive committee of each of the 10 geographical Districts, and 5 selected by the board of directors from its own membership.

The following members of the committee were present at the meeting:

T. F. Barton, F. Malcolm Farmer, and D. A. Quarles, New York, N. Y.; A. G. Conrad, New Haven, Conn.; C. H. Cutter (alternate), Seattle, Wash.; Mark Eldredge and H. W. Osgood, Washington, D. C.; B. E. S. Ellsworth, North Platte, Nebr.; A. H. Frampton (alternate), Toronto, Ont.; T. N. Lacy, Detroit, Mich.; Everett S. Lee (alternate), Schenectady, N. Y.; L. R. Mapes, Chicago, Ill.; M. A. Sawyer (alternate), Los Angeles, Calif.; J. G. Tarboux, Knoxville, Tenn.; R. W. Warner, Austin, Tex.; and H. H. Henline, secretary of the committee.

The following is the list of official candidates selected by the committee:

For President

Harold S. Osborne, plant engineer, operation and engineering department, American Telephone and Telegraph Company, New York, N. Y.

For Vice-Presidents

Karl B. McEachron, research engineer, high-voltage practice, General Electric Company, Pittsfield, Mass. (North Eastern District, number 1)

C. R. Jones, eastern transportation manager, Westinghouse Electric and Manufacturing Company, New York, N. Y. (New York City District, number 3)

A. G. Dewars, manager, system planning department, Northern States Power Company, Minneapolis, Minn. (Great Lakes District, number 5)

E. T. Mahood, engineer, in charge of area engineering

force, Southwestern Bell Telephone Company, Kansas City, Mo. (South West District, number 7)

E. W. Schilling, professor and head of department of electrical engineering, Montana State College, Bozeman, Mont. (North West District, number 9)

For Directors

K. L. Hansen, consulting engineer, Harnischfeger Corporation, Milwaukee, Wis.

W. B. Morton, senior field engineer, Philadelphia Electric Company, Philadelphia, Pa.

W. R. Smith, safety engineer, Public Service Electric and Gas Company, Newark, N. J.

For National Treasurer

W. I. Slichter, professor emeritus of electrical engineering, Columbia University, New York, N. Y.

The constitution and bylaws of the Institute require the publication in the March issue of *Electrical Engineering* of the nominations made by the national nominating committee. Provision is made for independent nominations as indicated in the following excerpts from the constitution and bylaws:

Constitution

Sec. 31. Independent nominations may be made by a petition of twenty-five (25) or more members sent to the national secretary when and as provided in the bylaws; such petitions for the nomination of vice-presidents shall be signed only by members within the District concerned.

Bylaws

Sec. 23. Petitions proposing the names of candidates as independent nominations for the various offices to be filled at the ensuing election, in accordance with article VI, section 31 (Constitution), must be received by the secretary of the national nominating committee not later than March 25 of each year, to be placed before that committee for the inclusion in the ballot of such candidates as are eligible.

On the ballot prepared by the national nominating committee in accordance with article VI of the constitution and sent by the national secretary to all qualified voters during the first week in April of each year, the names of the candidates shall be grouped alphabetically under the name of the office for which each is a candidate.

(*Signed*) National Nominating Committee
by H. H. Henline, *Secretary*

BIOGRAPHICAL SKETCHES OF NOMINEES

To enable those Institute members not personally acquainted with the nominees to learn something about their engineering careers and their qualifications for the Institute offices to which they have been nominated, brief biographical sketches are included in the "Personal" columns of this issue.

AIEE Technical Programs to Be Adjusted to Wartime

At the general session of the AIEE 1942 winter convention, Chairman P. L. Alger of the AIEE technical program committee outlined how that committee has planned to make the Institute's technical programs of the greatest service to the nation. The essential substance of Mr. Alger's remarks follows.

This is the first war convention of the Institute in 24 years, and only the third in our history. It is fitting, therefore, that we take stock, and adjust our programs so that we may render the greatest service to our country. With this in mind, the technical program committee has laid down a course of action. We expect to modify this as experience suggests, and, of course, we earnestly desire the criticisms or suggestions of every member with constructive proposals. The new policy has four features.

1. War-Effort Problems. Symposia on problems of immediate importance to the war effort will have a leading place in future programs. There are five such sessions at the 1942 winter convention, chiefly conferences where free discussion can be had with a minimum of time-consuming formalities. When subjects on which secrecy is required are discussed, provisions will be made limiting attendance to United States citizens, or in some cases to strictly accredited individuals. Papers at such sessions may be approved for delayed *Transactions* publication, whenever the material can be released. The procedure in these cases must be worked out by experience. I appeal for the co-operation of all Institute members in this matter.

2. Economy of Time and Effort. In view of the production stresses imposed on all engineers, committee meetings, writing of papers, and reports of every kind will have to be curtailed. For this reason, emphasis in the immediate future will be on conferences, without printed papers, rather than formal technical sessions. Papers at such conferences may be accepted for later presentation by title and printing where their importance warrants. We should like all members who have interesting new ideas or experiences to send in brief abstracts of them for consideration by the technical committees, even though they do not have time to write them out in full. The conference programs composed of such reports will be fully as interesting as the more formal technical sessions, and probably more up to date. Also, the Institute may save paper and printing, and devote the savings to other war efforts.

3. Planning Ahead. It is a condition of survival that we anticipate and prepare for coming events. This planning ahead must include action to be taken by city, state, and nation as well as our business and personal problems. By its nature, such planning must be a co-operative enterprise, our lives being all so interrelated. This planning is highly technical in character, so that engineers must have a large participation in it. Certainly, Washington can not do all the planning for us.

For these reasons, and in support of President D. C. Prince's extensive efforts in this field, the technical program committee is arranging various conferences on the general topic of planning ahead, enlisting the participation of other technical organizations wherever possible.

4. Civic Affairs. Planning is only one of many ways in which engineers can perform useful civic services. Just as lawyers and doctors have the bar and medical associations, and merchants the chambers of commerce, it is desirable that engineers have regional organizations of clubs or councils, to whom the public may look for technical leadership. The various professional engineering societies have made a start in this field, in which the Founder Societies, of which the AIEE is one, should play a major role. Therefore, the technical program committee is making a special effort to organize "civic affairs conferences" at all conventions, and the Sections committee is promoting similar local meetings.

Alfred Noble Prize Presented to AIEE Member

The Alfred Noble Prize for 1940–41 was presented to R. F. Hays, Jr. (A'36) of the research laboratories of the Sperry Gyroscope Company, Garden City, N. Y., at the general session of the AIEE 1942 winter convention on January 28, for his paper "Development of the Glow Switch" (AIEE *Transactions*, volume 60, 1941, May section, page 223). Mr. Hays is the fifth AIEE member to receive the award; a biographical sketch appeared in the January issue, page 48. Presentation was made by J. K. Finch, Renwick professor of civil engineering, Columbia University, New York, N. Y.

The prize is given in recognition of the excellence of a published technical paper written by a young man not more than 30 years of age and was established in 1929 in memory of the late Alfred Noble, one-time president of the American Society of Civil Engineers, American Institute of Consulting Engineers, and Western Society of Engineers, who made important contributions to the field of engineering in the construction of canals, bridges, and tunnels. Instituted in the form of contributions from friends of Alfred Noble, the prize is awarded annually during the year ending June 1 to a member of either the American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Mining and Metallurgical Engineers, Western Society of Engineers, or AIEE. Its recipient is selected by a joint committee composed of a representative from each of those societies, AIEE representative being H. S. Osborne (F'21). The award includes a certificate, and a cash prize, plus an allowance for traveling to the annual convention of the society of which the recipient is a member and at which the award is presented.

The glow switch, one of the most satisfactory devices yet perfected for the operation of fluorescent lamps, was invented by

Future AIEE Meetings

North Eastern District Meeting
Schenectady, N. Y., April 29–May 1, 1942

Summer Convention
Chicago, Ill., June 22–26, 1942

Pacific Coast Convention
Vancouver, B. C., September 9–11, 1942

Middle Eastern District Meeting
Pittsburgh, Pa., October 14–16, 1942

E. C. Dench (A'41) then at the lamp division of the Westinghouse Electric and Manufacturing Company, Bloomfield, N. J. Mr. Dench received the 1938–39 AIEE national prize for Branch paper for a paper describing this device; an abstract of the paper appeared in *Electrical Engineering*, November 1940, page 461. Mr. Hays (also at Westinghouse lamp division at that time), although assisted by other engineers of that company, was responsible for its development for practical use and adaptation to quantity production. The importance of this development is attested by the fact that more than 10,000,000 of these devices are now in service.

Conference Considers Civic Activities for AIEE Sections During the Emergency

Consideration of the ways in which AIEE Sections and individual members can give most effective help to their communities during the war emergency and afterward was the theme of a conference held January 28, 1942, during the AIEE winter convention. The responsibility and opportunities for engineers to take a leading part in the civic affairs of their own communities were stressed by P. L. Alger, chairman of the technical program committee, who presided. In these times of rapid changes, decisions must be made quickly, so technical information, and the experts on various subjects, ought to be organized for effective use in every locality, ready to meet whatever emergencies may arise, Chairman Alger said.

A conference arranged by the technical program committee was held at the AIEE South West District meeting at St. Louis, Mo., October 3–5, 1941, on the organization and experiences of local engineering councils. The discussion indicating that these local councils have been very successful in many communities aroused wide interest among Institute members. The present conference was arranged, therefore, to present the conclusions reached at the St. Louis conference and to offer suggestions for useful work which may be performed by such councils.

A report on the St. Louis conference was presented by F. A. Cowan, vice-chairman of the AIEE technical-program committee. R. H. Smith, deputy secretary, Pennsylvania Department of Commerce, and assistant director, State Planning Board, speaking on "Regional Planning in the State of Pennsylvania" provided some valuable suggestions on objectives and methods of local and regional planning.

Report on St. Louis Conference

At the AIEE South West District meeting in St. Louis, Mo., October 9, 1941, a conference was held on "How Can Engineers Render Greater Public Service? The Contributions of Local Engineering Councils to Their Communities." Reports were submitted by 14 local engineering groups or councils, of which 10 had representatives present and 4 had sent letters. From the reports and the related discussions, certain points were developed regarding the utility and type of organization for engineering councils, which may be helpful to engineers and civic organizations generally. With this in view, a record of the discussion and a summary of the ideas developed have been made available to various AIEE Sections. For this winter-convention conference we have thought that the presentation of some of the more important conclusions reached at the St. Louis meeting may serve as a background for further consideration.

There was general agreement in the St. Louis discussions that it was desirable for joint councils to carry on such activities as those undertaken by the St. Louis and Cincinnati councils. There was also general agreement that the professional engineers should join with the Founder Societies and other engineering organizations in forming councils on an equal basis of representation per unit of membership.

The thought was expressed that the problems discussed had to be attacked on a national basis by engineers acting together and not as separate groups. Engineering councils working in various areas would provide an instrumentality for effective planning on a nation-wide basis.

The conference expressed unanimous approval of a formal motion that the Institute continue to include such nontechnical or "civic affairs" conferences as a part of all convention plans.

ORGANIZATION OF ENGINEERING COUNCILS

Based on the reports presented by representatives of active councils and on the discussions at the conference, some of the essential items relating to the organization, functioning, and activities of an Engineering Council might be summarized as follows:

I. Purpose. In communities in which a considerable body of engineers reside it seems desirable that they form a co-operative group which will have as its objectives:

1. To further the public welfare by assisting engineers to participate in civic affairs; where their technical skills and experience can be utilized most effectively in serving the community, state, and nation.
2. To promote co-operation between all technical and scientific groups in the community to the end that they may consider and act jointly on all matters of common interest to the engineering and allied technical and scientific professions.
3. To further the activities of the member groups by carrying on the common service functions, such as publicity, directory and meeting arrangements, so achieving co-ordination of effort and economy in operation.

II. Functions. The activities of the council may conveniently be carried on by three principal committees and by such other committees or subcommittees as may be required from time to time. The principal committees are: "civic affairs," "program," and "publicity."

III. Membership. All engineering and allied technical and scientific societies are eligible as council societies. The president of each council society should appoint a specified number from his society to serve as members of the council for a stated term of office. Provision should be made that terms of only a part of the members expire at the same time and also for the reappointment of active and interested members, to insure continuity of effort. In order that members of the council be able to devote sufficient time to the work it is preferable that they do not hold executive positions in the member societies. Effective joint engineering councils require continuing membership of dynamic individuals.

IV. Financing. The usual plan to finance the council is to prorate the expenses among the component societies in proportion to their members. A maximum figure, frequently ten cents per member, is set for the permissible council expenditures. Normally, the services rendered by the council to the engineers of the community enable the member-societies to reduce their individual expenses by amounts practically offsetting the council expense.

V. Committee on Public or Civic Affairs. Accomplishments in the field of civic affairs will depend largely upon the fearlessness, initiative, and energy of the membership of the committee. The committee may function in a number of ways, such as:

1. Studying on its own initiative various community public works problems and others involving technical experience, such as flood control, traffic control, sewage disposal, airport facilities, water supply, technical man power, community planning, etc., and preparing of appropriate reports.
2. At the request of civic officials, co-operating in the consideration of specific problems with other civic bodies.
3. Holding meetings for the discussion of civic problems to which all members of the council societies are invited.
4. Arranging for publicity to make the facts and conclusions of such studies and meetings widely available.

In any such studies, it is desirable to allocate particular problems to the appropriate council societies.

VI. Committee on Program. This committee is usually composed of representatives of the program committees of the member societies. Its functions are to plan such joint or public meetings as seem desirable, and to ensure that the separate programs of the various societies do not conflict or overlap. By such joint planning of all of the engineering meetings in the community, a much wider coverage of important projects can be secured, and with a correspondingly greater participation by technical men and the public in general. Also, such co-operation will enable large public meetings to be arranged on appropriate occasions, at which nationally prominent speakers may be heard. Thus, the actual accomplishments of engineers as a group can be more favorably and widely known to the public, and their opportunities for service will be increased.

VII. Committee on Publicity. It is generally desirable to publish a council bulletin, either biweekly or monthly, in which will be listed all of the engineering and technical meetings and events of importance in the community. This can usually be mailed at second-class rates. This economy, together with the volume resulting from pooling the work of the different member societies, should enable much better news service to be given to all members at less cost than with independent action.

Also, it is desirable to publish an annual directory of all technical society members, forming a roster of scientific and technically trained personnel for the entire community. This annual directory performs a very useful service, by enabling talent of any particular type to be located quickly and accurately. Both the bulletin and the directory may contain advertising, the revenue from which may largely offset their cost.

Besides these two functions, it is desirable for this committee to arrange for newspaper publicity on all technical meetings and events, thus providing more accurate and complete reporting than otherwise possible on the service rendered and to be given to the public welfare in the future.

The developments since the preparation of the foregoing outline have tended to add

force to many of the points covered. The need for well-balanced engineering contributions to civilian defense and the problems relating thereto emphasizes the importance of a committee on public and civic affairs. Similarly during these busy times the difficulty of securing capable and well-qualified speakers suggests that joint programs arranged by a committee on program would be quite helpful.

Regional Planning in Pennsylvania

(R. H. Smith, deputy secretary of the Department of Commerce of Pennsylvania, was the second featured speaker at the conference on emergency activities. Essential substance of his talk follows.)

There is no precise formula for economic planning, nationally, regionally, or locally, for the simple reason that there are as many ways to approach the subject as there are individual human beings.

The Pennsylvania Department of Commerce is the baby department in the commonwealth organization. It is only two-and-a-half years old. It was created as a statutory department to make a scientific approach to the problems of economic maladjustment in the state. Its staff is small, and recruited largely from the engineering industrial field. There are three divisions: the Planning Board, a previously established board which had developed much of the foundation material needed; the Industrial Promotion Division; and the Tourist Promotion Division. Our tools are publicity in all its forms. The most useful effect of that publicity is not on the world outside of Pennsylvania but within the state.

Pennsylvania is a state of ten million people, with a great diversity of economic activity. We are as provincial as the devil in our state. I have found in one county men—good business men—who did not know what was in the next county.

If the department has any one slogan, it is that morale begins at home, and if we can build it there we have some chance of doing our job of publicity. We go out with a shotgun—with roadside publicity, and we go out with a rifle. We go after individual industries in the state, and after individual communities. We start with the community or industry that has the worst headache. After all, we can serve no purpose where everything is lovely.

In our approach to this work, we say to business and community leaders, "This is your job. The government—state or national—can go only so far. The initiative must come from your area. We are not going to try to solve your problems for you. We are going to try to feed you all the facts you need. We are going to help you in every conceivable way from our experience to organize yourselves to meet those problems. If you are not interested, we will go to the next borough with a headache."

We are very brutal about that because we are convinced that one of the difficulties today is that the old sense of self-reliance is just down a little bit. We have seen it down in our state and we have seen it come up and we believe that sense must be revived.

The department's functions include, among others, publicity; program of community self-appraisal; program of regional pooling of local resources—that means the pooling of ideas as well as pooling of physical resources and energy; program of scientific and economic research; and education.

Under our commerce law we are authorized to enter into any kind of scientific or economic research. With our funds we can enter into co-operative research arrangements with any appropriate agency in the commonwealth or outside.

We advocate and are promoting a balanced program of public works in industry. There have been some fallacies abroad as to industry and public works. All the educational systems, all the hospital systems, all the health and welfare agencies require industry for the manufacture of materials and equipment.

Therefore, in any community problem or any regional problem, when the cry goes up, "We must have public works," we say, "Where are you going to get the stuff to build them? Where is your industry?" In that way we try to keep a balanced viewpoint.

Pennsylvania—and this is true in every state of the union—is a large buyer of things that come from outside the state, outside the nation; that is, it was until recently.

There was in Pennsylvania a manufacturing deficiency of things we could make ourselves of over one billion dollars a year before the war. The story of how that happened is the story of the evolution of American industry and the growth and development of the United States. There is a legitimate reason for it, but that fact under the pressure of increasing costs of doing business, increasing Government overhead, the cost of this war, the cost of manufacturing and producing the essentials for war or for peace, will have to be considered. Engineers participate in those considerations more than any other professional group because they know how to get things done at lower cost.

What would we like to buy in Pennsylvania? Anything that we cannot make ourselves. We would like to make anything we would like to buy. A question we ask in every community, from the smallest to the biggest, is what are you buying in this community, that you see becoming scarce, or unobtainable, or prohibitive in price, that you could make here, and so put people to work by the use of technical facilities which we have not yet begun to use in this country?

It is our department's belief that we are at war in this world today only because we have failed to use the best ideas, the best technological practice, in the right place at the right time, and therefore must go through the process of reorganizing that situation. Now we have to go through it under pressure of war.

If I were asked to state very quickly what engineers could do in their localities in this situation, I think one answer would be this: Already you are being told by events what you can do in your home communities. Dislocations are beginning. They will increase. Nobody will escape!

I am not so sure that there is not a measure of good in our being compelled to look at this whole structure of our economy. We are going to clean house of a lot of economic nonsense and a lot of economic waste and a lot of bad industrial practice. War will do that for us!

The fact that we have unusual resources of ideas, men, modern facilities, materials, is our way out. Our job is their better organization. We look at the problems of Pennsylvania, whether state-wide or in the smallest community, from the standpoint of considering what there is that can be better arranged.

That is the same approach that is used in industrial management. All we are proposing to engineers and others in community work is that they extend their viewpoint beyond the four walls of the plant, and look upon the economic organization of the community or region in the same way.

We even try to stimulate handcrafts in Pennsylvania. At the State Farm Show recently there was an exhibit of handcraft work. Some blind boys and girls from the Overbrook School in Philadelphia were there making pottery. We had the first industrialists—the corn-planting Indians—making their bows and arrows, dolls, baskets, beadwork. We had some very skilled weavers. We had some people working in pewter and some on painted iron work.

We did that for several reasons. In the first place, a lot of people, young and old, are going to have difficulty in getting work in these years immediately ahead. Handcrafts provide something they can do. Incidentally, some of our needs are going to be hard to supply. The handcrafts can and will supply them. If people understand that they can do something about the situation, even a simple thing like making a rug for the floor, it will be a grand thing for the morale of this country.

If you can look ahead, these are the beginnings of new industry. Today, in Pennsylvania there is well over one million dollars worth of business annually in the handcrafts. Very lovely things can be made. We are going to expand these crafts. We are trying to get across the idea that if you want something there is a way to make it.

That outlines rather briefly the type of program we engage in. Why are engineers concerned in that? I think they are concerned, like everyone else, for the reason that ten years ago or thereabouts something happened to the American economic structure. When government, state and national, took over social security and unemployment relief, as well as regulation of economic life, beyond proper regulation, all the economic maladjustments of the nation were put in our present structure.

That is being passed back into our economic picture through the tax system which goes into the price structure. You and

I cannot avoid it if we want to. We are paying that price in the tax system. It occurred for the first time in our history only ten years ago. To me that is the most significant thing that has happened.

I mentioned this morning, apropos of Mr. Symonds' talk on the conservation of materials and the new uses of material, that we are going to find some new uses for men. That is a big part of the job. I think Mr. Prince referred to a bulletin from the National Resources Planning Board, "After Defense—What?" which I recommend to anyone who has not read it. I would like to quote it, in connection with what is happening to the economic pattern in the United States as the result of the war. These figures I am told have been increased since, because the bulletin was written before December 7, 1941.

"Today in 1941 there are 52,000,000 employed in America of whom 6,600,000 were in the military service or defense industries, roughly, about 10 or 12 per cent of our employable population."

Under the defense program, then called, which has since been speeded up, in 1942 we move up from 6.6 million in defense to 14 million. In 1943, we move to 18,500,000. In 1944, which is presumed to be the peak, 27 million.

That will explain why the Federal Government is talking today of 50 per cent of the national income for war. If half of our people are employed for military purposes, they are not producing anything that enters into trade. You and I as individual consumers cannot buy and use the military goods that are being made. Therefore, that change is showing the new uses of men that are developing in every community. Each of us is going to feel it in one way or another.

Over a year and a half ago the vocational schools in Pennsylvania had no interest in training young men and women for industry. In the last year and a half one million youngsters, men and women, have been specially trained in the new defense training program for industry. Why did they have to be trained? They were not ready. They did not know how to do the simple things. Were we ready? No, we certainly were not!

I have referred to the colossal job that confronts the national government in the organization for war and not for peace. Some elements of peaceful living must go on, even though we are fighting a war. Economy can be terribly dislocated if somebody doesn't get interested in it, and I don't know anybody better than the folks themselves back in their home towns.

If they get better organized to meet these terrific adjustments we are facing, they will be able to help the Government. They will be able to deal with the Government intelligently. Men come to us day in and day out telling us that they have been to Washington and had been given the runaround. Why shouldn't they get the runaround? They don't know what they want when they are there. They don't know what they have to sell. Ninety-nine out of one hundred of them just go to Washington. That is bound to happen in this sudden job we are confronted with, but let us be sympathetic with Washington. Let us also do the same kind of a job at home that we are asking Washington to do. Let us get at some facts, then we can deal intelligently with Washington or with any governmental agency.

We hear talk about postwar planning as though it were distinct from war planning. Postwar planning is planning now and it is planning now because we are late. We should have started 10, 15 years ago. We should have started when we first realized we had 10 to 12 million unemployed in the United States, because, after all, putting 10 million men back to work during the '30's is the same kind of a job that this country has to go through to organize for war; the same kind of effort we shall have to make when the necessity for war is past.

It will be a tougher job then, but let us learn how now. We are 10 years late. Had we tackled the unemployment problem in this country as engineers, as sound industrial organizers, we would have been more nearly ready for this war.

I should like to mention some of the things that we hear about in these larger over-all terms for the nation which you will find patterned right back in your home town. We hear about great market changes. Of course we are undergoing a great market change now, and the Government has first call on us. We have never considered market changes from the standpoint of what the customer could turn over to us in terms of goods; we have only considered what he could turn over in terms of dollars. For the last 25 years we have been industrializing the rest of the world, and then we wonder why they don't buy our manufactured goods. We are also wondering why they are more able to meet us in war; it is because they have industrialized. We have helped them do it. We have changed our market.

Another factor is government expansion; it is real. That is our fault as citizens. The more government expands, the more it shows that we back home are helpless, because government has expanded to do many things that ought to be done, which we back home did not tackle.

There is the fascinating story of industrial evolution itself: materials, machines, labor skills constantly changing the organization of industry. We forget that there is such a thing as economic location for these changes. We have heard a lot about our mature economy. It isn't grown up. It isn't even a lusty boy yet. Just because the population of the United States has spread to the Pacific Coast, and we have covered the land and built great industries, we are not grown up—far from it. Engineers know how to adjust to meet these changes, so engineers' voices must get stronger in industrial management and in government.

We have been preoccupied with the distribution of wealth. I could cite all the evidences of it: the labor movement, your movement and mine to get better income. Had we given half as much time to a better distribution of the opportunities to produce wealth, we would have gone somewhere. That involves men as well as locations and possibilities. We have industry obsolete in type and facility location, mixed up with the new. We have tremendous waste in our economy, but we also have tremendous opportunity.

Pennsylvania regional planning is a plan of action, not a blueprint, not a static form of something. We deal in facts, looking facts squarely in the eye and doing something constructive about them. We hear a lot of talk about greed. I think that is nonsense. We are all greedy. I think the trouble is that we are blind. We haven't looked at a lot of ordinary simple facts. They were cold. They were buried in statistics: government, private, educational; piled up, but not being put to work.

Pennsylvania is an empire in itself. It has more economic and industrial diversification than any other state of the union and therefore we believe it is a splendid laboratory in which to study the problem of better economic organization.

When we looked for specific things to be done, as I said, we looked for the regions that had the most headaches. Goodness knows we have them! Everyone knows about the anthracite region, and also the bituminous-coal area, which is a little better now. We go in and start to sow a lot of seeds, and it takes time and time and time. We look for a human sparkplug and try to sell that man the idea that he can do something about local problems. We can help the region, but its people can do something, too. Then we see what happens from there on. We keep coming back.

The other day I was in one of the principal anthracite cities, where there are four groups trying to get into the defense program. I asked each one, what are you trying to do to tie up with these other groups? The answer from all of them was "Nothing."

"What are you doing to tie up with OPM?"

"Nothing. We can't get to first base."

"How do you expect to do it then?"

We have begun to get tough in talking to those groups. We told them that they had better get together here, around a table, and begin to look at conditions in this town, in this region.

Here are some of the questions we ask when we get into community self-appraisal: What will your community do for a living? What does your town do for a living? (They never thought of that, that the town did something for a living.) What is the pattern of it? What goods and services do you produce here for sale, or are you depending on the Government to tide you over? They never considered that there are different types of human occupation. It makes a lot of difference whether they are doing nothing but merchandising in the town or are producing some raw materials or manufacturing or doing some processing. Then they are adding and creating wealth.

We had the story told to us in the United States Census Reports for years. Fortunately, in more recent years the census is being taken in ways that will tell us more. We can see this changing composition of occupation in our society.

Westinghouse photo

Registering for AIEE 1942 winter convention, left to right are: C. F. Wagner (F'40) and H. N. Muller (A'37), Westinghouse Electric and Manufacturing Company; J. E. Hobson (A'36), Illinois Institute of Technology; M. W. Smith (M'36) Westinghouse company; W. A. Lewis (M' 39) Cornell University; and A. C. Monteith (M '40), Westinghouse company

Where is it going? Manufacturing is going this way. Farming is going that way. Mining is going another way. Services are going their way. It is a trend, and it is a bad one, because after a while that trend will simply choke us to death. That is no design of anybody's, either in government or in business.

We have been in a period of change. During 50 or 60 years of that period, our capacity to produce wealth per capita over the whole population was increasing. That curve flattened out in 1910 or thereabouts and has turned downward. The population was going up at a 45-degree angle. That has flattened off. That is a national pattern, a world pattern, but you also will find it in your home town or region.

What is the distribution of employment in the various activities I mentioned? What is the distribution of capital investment in them? What is the distribution of domestic capital supported by them—homes, places to live, not only places to work? When you study the figures, you begin to see the situation getting out of balance.

How does the war affect each of these occupational groups in your territory in the demand for their normal services, in purchasing power, in competition by wartime activities outside the community, military and nonmilitary? Is the town being drained? Scranton, Pa., has lost 20,000 people in the last ten months. Five thousand homes are vacant today that had families in them eight or nine months ago. The prediction is that the region will lose just as many more unless it get some industrial diversification. The hope and the belief are that the rapid pick-up of production required for the war, if it is going to be accomplished, will mean such diversification.

It cannot be accomplished merely by expanding at existing locations, because living facilities are limited, and with tire rationing, how are men going to get to work? We must put some of our industries in those regions where we have towns already built. Management will have to be decentralized. That, of course, is one of the biggest shortages today. I think the gentlemen in Washington realize that we just don't have enough men trained and experienced in the science of industrial organization and production.

Today many products can be produced closer to their markets, then they have been in recent years. Two thousand-men plants used to be required to make high grade woolens; they can be made with modern machinery in 50-men plants. Think of the decentralization of production and the getting away from high-cost absolutely impossible centers to live in. Cost is making it imperative. Industry will have to get closer to consumers, particularly in the consumer-goods field. When you get closer to the consumer, you find some of the consumers working in the industry. We may get back in some industries to having the workers feel that they are a part of the production of the things they themselves are consuming.

DISCUSSION AND QUESTIONS

Chairman Alger: How do you organize these regions?

Mr. Smith: As I said in the very beginning, the approaches are as various as are human beings. We know, and you know, where the headaches are. We have a staff of about 6 field men roaming all the time. It could be 60 men to advantage. We send them into these regions. They find out who is who. I will give you an illustration.

I went into the city of Williamsport. I outlined our idea to the secretary of the Trade Association, whom I happened to know, and asked whether it made any sense to him.

He said, "Yes."

I said, "If you think it is good, aren't you going to use it?"

He said, "Wait, help me sell it."

"All right. You name three of your most progressive manufacturers. I will talk to them."

He named the three. I saved the toughest one for last. I was told he was so completely hard-boiled that he probably would not have time to see me. He agreed to see me. I went to work on him at once. Inside of ten minutes, he turned to his secretary and said, "Call a meeting of all the manufacturers in the county for next Tuesday. Mr. Smith, of the Department of Commerce, is coming up here to outline a plan."

"What do you want me to do, organize this plan for you?"

He said, "Hell, no. All I want you to do is tell them what you told me in the ten minutes you used for me, and I will employ a man and put him on the job to do it."

He did.

I might have approached it through a banker, or a prominent merchant. You have to find some human being who has the spark in him. The approach is as informal as that. Once you have got your man, his influence spreads a little and he gathers a little group around him, and if you should see that those groups are beginning to split, then you go in and just get as tactfully tough as you can and pull them together again. It is a tedious process.

Many of you have raised children. That is the kind of job it is. You are dealing with human beings. We are putting these people in the way of a few facts that heretofore have seemed irrelevant to them. We are bringing home slowly to them that such things as population changes, age composition, changes in technical factors, mean something in our economy. I think, as I said before, that the war itself can bring home to us a realization of that.

President D. C. Prince: About how many of these going concerns do you have now?

Mr. Smith: We have about 50 or 60 towns now beginning community self-appraisal.

Mr. Prince: How long has that been going on?

Mr. Smith: I think the oldest of that group is about seven or eight months now. We have been in existence only two and a half years. We spent the first year finding ourselves, finding out the picture in the state; then the war hit us; and then we were called upon to do a good many things that were not on our original program.

The United States Department of Commerce has been very much interested in this approach we have made. We have had some fine talks with the new Regional Business Counselor, a position which the United States Government has created in each Federal Reserve District. They have placed therein very capable men. We are now working with them, trying to see how their approach can be added to ours, and finally taken back into the home areas and started. This would mean each government level is

doing its own share. The United States Department of Commerce has the same approach as ours and their publications announce that "this is your job back home."

Mr. Prince: Do those groups need to have any clearance over a wider area than the individual town?

Mr. Smith: Yes, regional.

Mr. Prince: These 60 towns are organized; how are they going to clear?

Mr. Smith: We start them as towns; it is economic evangelism. Just as you would start with one man, we start with one town. If we get that town to see something, then we go over here and get another town, and after a while we have a number of towns in a common region, as we have been doing in the anthracite region. Now we are forming a regional economic council in the southern anthracite region.

That started in a town of about 5,000 population. It was the capital of the bootleg-coal area. One man in that town decided he was going to get some industry, however small. He brought in two small industries and demonstrated that it could be done. He did it alone. He has a nice little town and his fame spread locally. Now that whole southern anthracite region is meeting regularly. At each of their meetings we feed them a little bit more. You can't give them the whole story at once. If you can dare them to take hold of the thing, you can get somewhere. So it grows regionally.

In other regions, the approach is different. We go to a center to start. There is a natural center, a market, for every one of these big regions. I have a big map on my office wall which shows the natural resources base of the state and beside it a population distribution map, a dot map, which shows where the flies have flocked to the sugar. That is what it looks like. The sugar was there; it is still there; but a lot of the flies have moved away because they didn't know how to get at it. That map shows how men find locations, and why towns grow, and how communities grow. There is no formula. There is a man who sees something and gets an idea, and is determined to find out whether it is worth anything or not.

Mr. Landis: Many of these communities you referred to have organized engineering societies; do you find the engineering societies a prime moving factor in the work you are doing, or is it principally the commerce club?

Mr. Smith: There is no rule on it. I have yet to find an engineering society a prime moving factor.

After all, it is a new subject. So far as we are concerned, in reality it is only ten years old. It is a little older than that but we didn't know about it before. The engineering societies have not been among the groups needed, neither have chambers of commerce. Here and there a real chamber of commerce secretary helps. Manufacturers associations are not usually of much help, but here and there one of them has a real secretary.

There never has been any organized group consistently leading in the attack on these problems in the state. Labor does not have the initiative in this respect. When we go into a region, if there is a labor leader who has some economic sense—and many of them have such sense—we get him into the picture. No more than any other group does labor have representation. We have all been passing the buck, even as groups.

Chairman Alger: Have you found a way to look over the natural resources and then take a certain thing to, let us say, Dean Sackett and say, "You study the thing in the college and possibly develop some new process"?

Mr. Smith: I forgot to tell you how we try to bring in the colleges and universities. When we first got into the work, I tried to sell the colleges and universities directly, but soon found that wasn't the way. Now we build fires under the colleges. We go into a group that is having a real difficulty. Many of the colleges have been doing a swell job in particular problems, but not in the organic problem. It has been too new; it hasn't been forced on them. We get a group started, and I say, "Look at the research we have to do on this thing! Why don't you use your colleges?" They have never thought of that.

In Easton they had organized a very progressive group. The secretary, in talking to one of our field men, said, "Why can't we get some men to help us on this? We don't know how to go about it."

"What is that up on the hill?"

"Lafayette College," was the answer. "I hadn't thought of that."

Two of the Lafayette men are now working in that group. You can focus the problem in the community through some men who have some courage and determination to do something about it, and then you go to the colleges and universities and the school systems and the state departments and the federal departments and ask for help.

Instead of going to them, we try to get them to come to us for help. It is a perfectly simple technic. It just takes time.

Dean R. L. Sackett: I think the audience may be interested in the career of Ray Smith. He is a graduate of electrical engineering at Pennsylvania State College and was experienced with Westinghouse Company in Pittsburgh where he grew up. In the course of time, he came back to Pennsylvania State College and became controller. Now you understand where he got part of his engineering education. Where did he get his financial and human instinct, which is perhaps a controlling feature of his attitude? While he was controller, of course, he dealt with finance and he also dealt with a bunch of deans—obstreperous deans of engineering, and such people—and that is where he developed his acuteness in dealing with the human animal.

His approach to this subject has been that of an engineer—he starts with the facts. He is one of those high-class politicians who knows how to deal with the community and with the individual.

Vice-President J. L. Hamilton: Perhaps I may elaborate very briefly on what Mr. Cowan told you about the St. Louis record and the Associated Engineering Societies' activities. That didn't just happen; it came about by planning and hard work.

Some 25 years ago that activity started, around the St. Louis Engineers Club. Although we are pretty far west, we are the third oldest engineering society in the country, being more than 75 years old and active throughout all that period.

The Associated Engineering Societies was only one of its activities and through that was developed a consciousness of civic activity. We have never had an engineer mayor of St. Louis, although we have come close to it. All the operating departments of the city of St. Louis have for at least 20 years been run by engineers, who are active members of the Engineers Club of St. Louis.

Most of these jobs that Mr. Smith and others have pointed out are engineering jobs—running the street railway system, transportation systems, building streets, sewers, parks.

We do have a big economic problem in this country. We have had it long before the world war came and we have all the elements of the problem with us still and will have them, apparently, when the war closes. What are we going to do about it?

There are lots of things we can do about it, and one is to think not only concretely as engineers but abstractly as economists, as psychologists. Those two sciences that we need badly are undeveloped, but don't let us sit idly by because we don't know too much about them, without making an effort to learn something.

A few years ago a start was made on simplification and elimination of waste. We, as a nation, must apply the true yardstick of efficiency, and that means the broad over-all efficiency that includes economics, sociology, and engineering.

Chairman Alger: Mr. Smith, would you care to make a few more remarks?

Mr. Smith: We are living with this thing day in and day out, meeting groups, meeting individuals. I think if I could sell one idea, I could accomplish my purpose wherever I go. For some strange reason—I suppose the philosophers could explain it—we forget that the essence of life is change. If we would simply take the biological and evolutionary doctrines, we would see them manifested in our economy. We buck change, every change that comes along. That is human nature.

We are going through tremendous changes. If what is going to happen is only partially what I think, we are going to have some fun making these adjustments! Somehow, however, it doesn't scare me a bit, because day in and day out I see what looked like impossible situations coming up and being cleared by men of all professional types, who are meeting these problems coolly, quite easily, quietly, with very little controversy.

There seems to be a new note of humility in this picture. We see good management, good consideration for the personnel, good consideration for research; there is a tremendous leavening all through the country. The thing we can't afford to do is choke it. We have been in terrific danger of that—that we would choke that creative force that has made our great profession.

Session and Conference on Education Held at Winter Convention

Problems confronted by education during the present emergency period and also during the postwar period constituted the principal topics of discussion at this session. H. N. Walker, member of the AIEE committee on education, presided. An abstract of the informal conference paper "A Backward Look for a Forward Plan," by F. C. Hockema, Purdue University, Lafayette, Ind., was presented by Professor R. W. Warner, chairman of the AIEE committee on education.

A BACKWARD LOOK FOR A FORWARD PLAN

Professor Hockema's paper gives the views of some nationally known educators and employers of college graduates. "A backward look," he states, "with doubts, over the changes that have taken place in higher education during the past few years, especially the last two years, and the proper appraisal of them will give us an outlook with some degree of certainty on the changes which we may expect in the near future and enable us to make plans accordingly. The national-defense program has imposed immediate changes upon institutions of higher education—changes which in all probability will have an enduring effect. Other changes, resulting from the economic and social problems which we have encountered and others which we are bound to face after this world catastrophe, will have a lasting and enduring effect, bringing with them many more changes in higher education."

Speaking of curricula for the training of electrical-engineering students, Professor Hockema says: "Instead of fitting the student to the curriculum, which is so often the case, the college curriculum should fit the student. A student can, with proper advisers, map out a program of study, activities, and experiences which best match his aptitudes and abilities. For some students this training may be broad and general, and for others it may be specifically vocational. If an engineering college has one curriculum, then only students who have the proper aptitudes and abilities to master that curriculum should be admitted. There seem to be at least a few important items upon which all educators and employers agree. These items are that every college man should be: (1) a master of the English language in both the written and spoken form, (2) thoroughly trained in fundamentals, (3) a thinker, (4) personable, and (5) a good citizen."

In his "conclusions" Professor Hockema says, in part: "The present demand for trained engineers, trained workers, trained minds, skilled technicians, and for individuals with good health and surplus physical energy has placed a new and greater emphasis on education, its objectives, techniques, scope, functions, cost, and sources of revenue for its support.

"After the aims and objectives of each course and program of study have been concisely and specifically formulated, the next major problem is to select programs which will be of maximum benefit to the individual making him an asset to his community, state, and nation. A program of study should be selected which is in harmony with the student's mental and physical capacities, personality, mental attitude, character, initiative, and judgment. This might mean the termination of a program of study at the end of any quarter, semester, or year, and the receipt of a certificate instead of a diploma.

"The admission standards for each program of study should be high, rigid, and adhered to so that only qualified individuals are admitted, making it unnecessary to have a large percentage of failures. The student who satisfactorily completes a program of study which does not lead to a degree should be awarded an appropriate certificate of achievement.

"Each student should be made aware of the high and exacting standards of attainment of those to whom the schools, colleges, or universities give a stamp of approval, regardless of whether the stamp of approval be a certificate or a diploma.

"There should be provided state and national examinations for students, graded by outside committees which would be more fair and at the same time give a check on the teachers. The instructor could then boast about the large percentage of his students who passed instead of boasting about the large percentage who failed his course under the present system.

"The curriculum should be made up of fundamental subjects and fundamental principles, and each subject should be taught in such a way that the individual forms the habit of understanding thoroughly the subject matter and processes. Each student should be given maximum opportunity to develop creative thinking.

"Irrelevant subjects should be deleted from the program of study, and each of the fundamental subjects should be revised to provide the individual with these fundamental principles which will be of paramount value in the trade, vocation, or profession for which he is being trained.

"Specialization in professional undergraduate programs of study should be minimized; the graduate student, however, should be allowed to specialize in his chosen field.

"The student load should be reduced in order to allow sufficient time for a thorough mastering of each subject. If necessary, the curriculum can be spread over five, six, or seven years.

"Provisions should be made for more after-college education, whether that be training on the job, graduate studies, or returning to the university after graduation for intensive or broadening courses.

"While it is important to provide the student with a curriculum that is most suited to his mental and physical capacities, aptitudes, and interests, it is of greater importance to have the proper persons teach the courses.

"No expense should be spared in obtaining teachers who can teach—individuals who know their subjects thoroughly and are imbued with enthusiasm and a keen interest in the training and development of students. Improved teaching should start with the elementary schools, but it should not end there. If we are going to have improved teaching we should offer greater incentives to those competent individuals who can teach and who are also interested in research and writing."

POSTWAR REFRESHER PROGRAMS

In his informal conference paper on "Refresher Programs at the Graduate Level in the Postwar Period" Professor Harold W. Bibber of The Ohio State University, Columbus, stated that "The unsatisfactory experiences of many engineering graduates in fitting into civilian engineering work after having been in the armed services in World War I is sufficient cause for us to be concerned about a constructive contribution to the solution of the problem. A detailed statement of the need for a refresher program will be of help in seeing what some of its characteristics should be. It is recognized that certain assumptions have been made about the future course of the present war which may not turn out to be valid, but the following items will cover most of the causes of the need:

"1. Graduates were engaged in activities of a nontechnical or only slightly technical character during their military service, and are "rusty" on their fundamentals as well as on specialized subject matter.

"2. Graduates received modified or abbreviated courses in their engineering schools to better fit them for military service, or to advance their dates of graduation. (Up to December 1941, no actual changes in engineering curricula had been reported, but several were under discussion.)

"3. During the period of their defense services graduates changed their professional goals from those fixed in their undergraduate days.

"4. Developments of a basic character in the theory of electrical engineering in its several branches which graduates can most easily learn by formal study in a school, especially if laboratory practice is essential to a thorough grasp of the new material.

"5. Placement in appropriate positions is likely to be much easier from a school as compared to graduates trying to do this entirely on their own. There are possibilities of group co-operation.

"6. Re-establishment of desirable habits of intellectual work under sympathetic direction.

Characteristics of a Desirable Program. "To meet the social need, graduates of a caliber not thought to be suitable candidates for master's degrees should be admitted for at least a trial period under this program. A certificate could be issued to those who satisfactorily complete part of a program, but do not qualify for an advanced degree.

"Individualized personnel work of a type not ordinarily found at the graduate level should be undertaken to provide educational and vocational guidance of a practical character. For some men who have suffered shock, expert psychological services may be needed, even though they have received hospital treatment before returning to school.

"Of value to each returned graduate, whatever his special professional interest,

would be a high-level well-integrated program of economics, sociology, mass psychology, and political science, in which the then existing status and probable immediate trends in the social life and organization of the United States and the world would be covered. Such a course should be offered to seniors and regular graduate students at the end of the war by all engineering schools.

"Comprehensive review courses of a type seldom offered in any engineering curricula should be organized. For example, a review or refresher course in mechanics for electrical engineers would cover statics, dynamics, and strength of materials in 20 lectures or less.

"Closer supervision of the work of students in these refresher courses will be needed than is customary at present for graduate students. Time spent in nonintellectual work will have unfitted some of these graduates for immediate self-direction and self-discipline. Much patience and tact on the part of teachers will be needed in handling them.

"Since more of the electrical-engineering graduates in the armed services will have been engaged in communication work than in any other branch, and since only a limited number can be absorbed into that type of work after the present war is over, a large part of the refresher program should be aimed at preparing the graduates for work in power and manufacturing companies or public power projects.

"The cost to the student of a refresher program might be reduced below the fees for regular graduate work by the use of municipal, state, or federal funds. The present Engineering Defense Training program of the Federal Government provides a precedent. An educational program could be offered in lieu of the cash bonuses given by government agencies after World War I.

"There will be a need for full-time refresher programs at all engineering schools, and for part-time evening programs at schools in metropolitan centers."

EVENING GRADUATE COURSES

The third and last paper in this session was "Evening Courses at Graduate Levels—a Challenge to Colleges of Engineering" presented by Professor Robin Beach of Brooklyn Polytechnic Institute. This paper was published in the AIEE *Transactions*, February section, pages 88–94.

All three papers stimulated considerable discussion among those present at the session.

Session on Power Generation and Transmission

A session on power generation and transmission, sponsored jointly by the committees on power generation, and power transmission and distribution, was held January 26 during the AIEE 1942 winter convention, with W. L. Cisler and Philip Sporn, respective chairmen of the two committees, presiding.

In an address, "Power for War Needs," J. A. Krug, chief of the power division of the War Production Board, pointed out what was being done to cope with the enormously increasing demand for power for production. He indicated that there is now available for service over 51,000,000 kw of effective power capacity, in the United States, that 2,200,000 kw of steam capacity and 1,000,000 kw of hydroelectric capacity will be installed in 1942, and that in 1943 2,000,000 kw of steam capacity and 1,000,000 kw of hydroelectric capacity will be installed. The power division of the War Production Board is attempting to schedule generation-equipment deliveries for 1942 with manufacturers and mobilize the power resources of the country through interconnections, he further stated. (Essential substance of Mr. Krug's address appears elsewhere in this issue.)

C. J. Hoslag, president of the Electric Arc Cutting and Welding Company, in an address entitled "Reaction Heating Aids of Welding High-Pressure Steam Pipe" pointed out the advantages of heating materials before welding was done on high-pressure steam piping.

The report of the joint AIEE–ASME committee on a specification for speed regulation for prime movers intended to drive electric generators, presented by Chairman M. J. Steinberg, indicated that progress is being made toward standardization of requirements and better understanding of the problems connected with speed control.

A paper, "Facilities for the Supply of Kilowatts and Kilovars," by H. K. Sels and Theodore Seely, Public Service Electric and Gas Company, Newark, N. J., indicated the desirability of considering wattless current over an entire system the same as direct power current and pointed out how this approach to the planning problem had improved conditions on the particular system described. In the discussion a plea was made for metering of kilovars rather than a metering of power factor. It was pointed out that a kilovar meter was much simpler than a power-factor meter and it was also thought that wattless power should be dispatched the same as watts are now dispatched. One discusser questioned whether or not pull-out might be experienced if correction of power factor were carried too far on existing machines; another pointed out that the correction of power factor allowed the increasing of the kilowatt load on existing generators without undue hearing.

A paper on "Synthetic or Equivalent Load-Curves" by R. F. Hamilton, consulting engineer, Washington, D. C., was presented by title only. (*A. C. Monteith, vice-chairman, committee on power generation.*)

Power-Generation Session

A session on power generation was held January 26, 1942, during AIEE winter-convention week, with W. L. Cisler, chairman of the power-generation committee, presiding.

"A Turbine-Governor Performance Analyzer," by W. O. Osbon, Westinghouse company (November 1941 *Transactions* section, pages 963–7), described a new instrument designed to allow a more complete analysis of turbine-governor performance. The recording part of this instrument is a magnetic-type oscillograph which allows a complete co-ordination of the various movements of the governor under test conditions. One discusser described a different type of instrument, giving data on speed governors but the information was considered less complete than that given by Mr. Osbon.

The next two papers, "Control of Tie-Line Power Swings," by C. Concordia and H. S. Shott, General Electric Company, and C. N. Weygandt, University of Pennsylvania, and "Supplementary Control of Prime-Mover Speed Governors," by J. B. McClure and S. B. Crary, General Electric Company, presented problems connected with tie-line power swings and the supplemental control of prime-mover speed governors for tie-line swings. During discussion it was pointed out that some of the limitations of turbine control were involved in the temperature changes and effects in the turbine and that possible limitations in control would be dictated by temperature drops in the turbine rather than by electrical demands.

Some interesting information was presented in connection with a western system where it was formerly thought that one-tenth variation of frequency was attended by a variation of one per cent in load. A test conducted by isolating 60,000 to 100,000 kw of load indicated that this conclusion was correct. This test showed that for one-tenth per cent variation in frequency there was approximately two-tenths per cent variation in load. The discusser stated that the difference between these two was now definitely attributed to voltage variation. The complete system was tested for a range of voltage up to three per cent change with all the regulating devices blocked. This showed a change of 50,000 kw in a total load of 1,620,000 kw. One of the discussers thought the idea of an automatic tie-line control fundamentally incorrect, stating that experience had led to the exclusion of all automatic frequency control from the system with which he was associated.

The question as to whether the load change dictated by tie-line control could be handled by the boilers was raised. Information given on gas- and pulverized-fuel-fired boilers indicated these to have a fairly connected response. It was not believed, however, that stoker-fired boilers would respond much faster than $1^1/_2$ per cent load per minute. (*A. C. Monteith, vice-chairman, committee on power generation.*)

Conference on Substitute Materials in the Communication Industry

Representatives of all branches of the communication industry participated in this conference, which reviewed progress made by that industry in curtailing the use of critical materials. E. J. O'Connell, past chairman, committee on communication,

presided. The conference included prepared discussions by the following: R. E. McConnell, engineering consultant, War Production Board, Washington, D. C.; P. J. Howe, Western Union Telegraph Company, New York, N. Y.; R. L. Jones, Bell Telephone Laboratories, Inc., New York, N. Y.; R. S. Burnap, Radio Corporation of America, Harrison, N. J.; J. D. Booth, Westinghouse Electric and Manufacturing Co., Baltimore, Md.; E. A. Leach, General Electric Company; C. R. Miner, General Electric Company; W. F. Cotter, Stromberg-Carlson Telephone Manufacturing Co., Rochester, N. Y.; R. B. Shepard, Underwriters Laboratories, New York, N. Y.; E. E. Thum, editor, *Metal Progress*, Cleveland, Ohio.

The discussion was opened by Mr. McConnell, who outlined the present status of critical materials and presented production statistics. When considering substitutions, he pointed out, we must go "up the scale" from a material of which a given quantity is available to some other material of which a greater quantity is available. The use of steel in place of brass in shells promises to be one of the most important substitutions. The rubber problem is really one of the most acute problems facing the United States today, although the manufacture of synthetic rubber in increasing quantities will relieve the situation. Plastics will not replace much steel, because the materials required for the manufacture of plastics are also critical. Mr. McConnell emphasized that the list of substitutions must be expanded. He also indicated that the Engineers' Defense Board (of which he is chairman) has been functioning "over a rather wide area."

Representatives of the communications companies indicated that their problem is to expand their services so as to accommodate the increased traffic resulting from the war effort without using any more than necessary of the critical materials. In open lines, steel and galvanized steel wires are being used where possible; also copper-clad steel. Line hardware is being painted instead of galvanized, in order to save zinc. Savings of critical materials also are being effected by deferment and curtailment of new construction as well as by substitutions.

In some instances, equipment designs are being frozen in their present form so that manufacturing can continue without retooling. The copper in noncurrent-carrying parts is being replaced by other metals and by plastics; copper-clad steel is being substituted for tinned bronze. In some instances, worn parts of communication machines and devices are being reclaimed by spray metallizing. In this process, the metal that has been worn away is replaced by a spray process.

Nickel is an important ingredient in both springs for relays and other devices, and in magnetic alloys. As far as instrument springs are concerned, the properties are critical, and substitution difficult. Also, with weak currents such as prevail in telephone circuits, the high-permeability alloys (which contain large proportions of nickel) are important; nevertheless, iron and silicon steel are being substituted where possible. Quartz, which is imported principally from Brazil, is necessary for precision oscillators, and for filters. No substitute has been found, but considerably smaller crystals are being used.

Representatives of the communication-equipment manufacturers likewise indicated that they were faced with the necessity for increasing output, but at the same time curtailing the use of critical materials. The two most critical materials involved are aluminum and copper. Steel is replacing aluminum very largely for shielding purposes. Copper-sprayed or -plated steel sheets also are being used. Plastic chassis parts with metal coating have been experimented with, but so far the results have not been successful. One manufacturer reported the use of zinc for shielding purposes in place of aluminum; this requires no retooling.

Permanent-magnet loud-speakers are being replaced by electromagnetic types, and smaller magnets are being used. In transformers, conservation of materials is being effected through the design and manufacture of miniature units using powdered-iron cores, which because of their small size require little or no shielding. One company reported rather extensive use of plastics including Polystyrene, which is not considered critical at present but may become so. Fibrous glass is being used in some instances in place of rubber for insulation.

One of the most important substitutions reported by one manufacturer consists of the use of injection-molded Mycalex in place of steatite for insulating pieces of various forms and shapes. Mycalex can be molded to proper shape and dimensions whereas bushings and bearings in steatite parts require grinding.

R. B. Shepard of the Underwriters Laboratories urged that the fire hazard be kept in mind and that substitutions involving increased fire hazards not be made. He indicated that such substitutions would not be approved by the Underwriters Laboratories. He mentioned the use of paint in place of zinc galvanizing coating and also indicated that sprayed galvanizing coatings saves zinc, as compared with electrogalvanizing.

E. E. Thum, editor, *Metal Progress*, closed the discussion. He stated that the engineers in the communication industries had done a more thorough job in the matter of substitutions than had those in many other industries. He expressed the opinion that plastics would not be available in any huge quantities. He indicated that silver has good possibilities for use in current-carrying parts; also in solder (as a substitute for tin). He urged that engineers look for substitute materials that are not likely to become scarce. He said that the communication industry fortunately is not bound by restrictive traditions and that specifications can be changed fairly readily to accommodate the use of substitutes.

The conference seemed to indicate that in general substitution means the use of more expensive materials, and curtailment means designs requiring more labor in fabrication—either resulting in higher costs. In all substitutions, efforts are being made to keep the quality up to present standards. For some materials, no satisfactory substitutes have been found; here only curtailment remains. Steel is being substituted very largely for many of the more critical metals.

Conference on Defense Lighting

The significance of controlled lighting for civilian and military protection during air raids was brought out by the speakers at the conference on defense lighting, sponsored by the AIEE committee on the production and application of light, and held January 26, during the 1942 AIEE winter convention. E. M. Strong, chairman of the committee, presided. Discussion leaders were Lieutenant-Colonel Edward B. Towns, Second Defense Area, New York; Colonel Walter P. Burn, Office of Civilian Defense, Washington, D. C.; Kirk Reid, General Electric Company, Cleveland, Ohio; and S. G. Hibben, Westinghouse Lamp Division, Bloomfield, N. J.

Colonel Towns spoke from the military point of view on the extent to which total "black-outs" would be necessary in the two military defense areas which are the most likely to be subjected to attack first. He defined these areas as 300 miles inland from the east and west coasts. He pointed out

Westinghouse photo

At the conference on national defense lighting, sponsored by the committee on production and application of light, are (left to right): S. G. Hibben (A'34) one of the speakers, and D. W. Atwater (A'34) past chairman of the committee, both of Westinghouse Electric and Manufacturing Company; K. M. Reid, a speaker, General Electric Company, Cleveland, Ohio; and E. M. Strong (M'40) chairman of the committee, who presided at the conference, department of electrical engineering, Cornell University

some of the difficulties which a total black-out might cause and expressed some doubt that such would be necessary in view of the type of enemy attack which military authorities consider possible at present. The Interceptor Command on either coast, however, has the authority to command "black-outs" of any degree, and Colonel Towns assured the audience that tests were under way to determine a program which would give maximum protection from the enemy with a minimum degree of deviation from normal civilian lighting habits.

Representing the national headquarters of the Office of Civilian Defense, Colonel Burn explained their national program, and described some of the duties and activities of local defense officials. He pointed out that the plan had been carefully worked out for American conditions, not simply taken over from British practice. Each community is to have a defense council, with headquarters at a control center. The council will be made up of the heads of police, fire, and public-works departments, of utilities, representing all services, of an emergency medical service, and of the air-raid warden service. Specially trained bomb removal squads under the police force, crews for spotting fires and dealing with incendiary bombs under the fire department, and a decontamination squad to deal with gas are included in the setup. Cleaning-up operations will be under the department of public works and regular crews will be used in restoration of utility services. He noted that the air-raid wardens will constitute a separate service, not reporting to the police department, as the finest type of civilians are needed for this work. The city or town control center reports either to a county office, or in some states, directly to the state office, and state offices in turn report to regional offices, the regions being coterminous with army command areas. He explained that this organization was planned to deal only with the problem of civilian protection, other organizations concerning themselves with morale, nutrition, and welfare.

Still another organization, partly civilian, but operating directly under the Army Interceptor Command, watches for approaching planes. All planes are reported by "spotters" to filter centers, and when enough reports indicate the presence and direction of hostile planes, the filter center reports to an information center, from which the warning spreads outward. Communities must have provision for quick black-out, the degree being determined by the Interceptor Command, with present orders requiring complete black-out.

A precautionary black-out may be ordered in advance of possible raids, if, for example, the Interceptor Command has information of the approach of an aircraft carrier. News of such black-outs will be given through ordinary channels of information—newspapers, radio, etc. The Government will issue a model black-out regulation, to be enforced by state and city ordinances. Colonel Burn suggested that a committee of the Institute be designated to which such a regulation could be submitted for preliminary consideration. He also suggested that such a committee might provide a table of wattages and distances for use in developing such a regulation.

Recent OCD publications on the duties of air raid wardens were displayed, indicating the great amount of work already completed. "Black-out" instructions were being prepared by the Army engineers in co-operation with the Office of Civilian Defense and would be available as soon as possible, according to the speaker. In reply to questions from the audience, Colonel Burn indicated that "black-out" street lighting specifications were almost ready, and that specifications for railroads, buses, and other public carriers were being formulated. He cautioned against the use of blue lamps in any manner during air raids and against local ordinances inflicting heavy fines for noncompliance with local black-out rules which were not as yet recommended by the military authorities.

Following Colonel Burn, Mr. Reid illustrated with slides certain fundamental seeing problems which the illuminating engineer must consider when lighting levels are of the order of "star light." Brightnesses permissible without giving enemy aid were discussed, and he described briefly how these brightness data were being applied during black-outs for greatest benefit to the civilian population and their activities. Mr. Reid ended his talk with some pertinent data on the value of red versus blue for black-out lighting. He showed data that indicated conclusively that red provides better visibility on the ground and is less visible from the air, than is blue.

The session concluded with a demonstration lecture by Mr. Hibben who presented entertainingly some of the useless equipment now available at department stores for black-out purposes, such as "black" black-out candles. The fact that manufacturing effort, and in some cases, critical materials go into these gadgets makes the problem of restraining their purchase a serious necessity. Mr. Hibben expressed his belief that a total black-out of streets, homes, and factories hardly seems necessary under present conditions, and that a "dim-out" might suffice. In "dim-outs" certain landmarks, bridges, street patterns, signs, might be turned out during the period of a raid, but homes and suburban areas might well keep normal lighting without hazard to themselves. Factories must under no circumstances stop operation during raids, according to Mr. Hibben, but should provide black-out curtains or other means of concealing interior lighting from the exterior. These black-out measures should be so arranged that they can be taken down during the day in the interest of employee morale, or such high-quality lighting should be installed that permanent window black-outs will not prove depressing and noticeable during the day. The speaker concluded by demonstrating some of the more recent advances made in the fields of phosphorescent and fluorescent paints, plastics, and other materials, used with the new compact fluorescent and mercury-vapor light sources designed to produce ultraviolet light for "black lighting" purposes.

Discussions and questions from the audience were so active that adjournment did not occur until 5:30 p.m. Approximately 200 members and guests attended this conference. (*O. P. Cleaver, secretary of the committee on production and application of light.*)

Switching-Equipment Session

A session on switching equipment was held January 27 during the AIEE 1942 winter convention under sponsorship of the protective devices committee; J. R. North, chairman of the committee, presided.

The first two papers, "Field Tests on High-Capacity Station Breakers," by H. D. Braley, Consolidated Edison Company of New York (January 1942 *Transactions* section, pages 31–5), and "Field Tests on High-Capacity Air-Blast Station-Type Circuit Breakers," by H. E. Strang and W. F. Skeats, General Electric Company (February 1942 *Transactions* section, pages 100–04), outlined the construction, design, and field tests of a new air-blast breaker. These papers were of interest not only as far as the breaker was concerned, but also because the field tests were made with the highest concentration of power ever undertaken up to this time.

In discussion it was pointed out that the development of air-blast breakers had not been slower in the United States than in Europe because the European designs had a limit of 800,000 kva in interrupting capacity while much greater capacities were necessary for the concentration of power in the United States. It was also stated that the previous high for field testing had been 30,000 amperes whereas in these papers, field tests were described for 65,000 amperes and laboratory tests up to 105,000 amperes. One discusser presented data to show that the recovery voltage for the tests in the first paper was a maximum of 390 volts per microsecond, while calculation indicated that 2,400 to 4,600 volts per microsecond would be experienced on the system.

Some interesting slides were shown by one discusser to illustrate studies that had been made in breaker design. He urged the elimination of oil because his slides of oil breakers tested to destruction showed evidence of large volumes of smoke with fire, whereas with the compressed air-breaker, failure causes little disturbance.

"Field Tests and Performance of High-Speed 138-Kv Air-Blast Circuit Breaker," by Philip Sporn, American Gas and Electric Service Corporation, and H. E. Strang, General Electric Company (January 1942 *Transactions* section, pages 1–6), was presented by title only, having been presented at the Pacific Coast Convention in August 1941.

The papers, "A 2,500,000-Kva Compressed-Air Power-House Breaker," by L.R. Ludwig, H. M. Wilcox, and B. P. Baker, Westinghouse company, and "High-Capacity Circuit-Breaker Testing Station," by J. B. MacNeill and W. B. Batten, Westinghouse company (February 1942 *Transactions* section, pages 49–53), described a 2,500,000-kva air-blast breaker,

a new high in this type of switch, and also described the laboratory facilities used in testing this breaker up to full capacity. The paper, "A Fast Circuit Breaker," by D. I. Bohn, Aluminum Company of America, and Otto Jensen, I-T-E Circuit Breaker Company (*Transactions* pages 165–8), described a new high-speed circuit breaker now in operation in the anode circuits of multianode mercury-arc rectifiers.

One discusser pointed out that his company with its associated companies had made available air-blast breakers four years ago and that they now had experience from 100,000 kva at 2.3 kv to 2,500,000 kva at 220 kv. Several questions were raised on the practicability of a synthetic test circuit described by one author. Some thought that it deserved close scrutiny as it might give misleading results, while the authors believed that the tests showed it to be more severe than corresponding field conditions.

Some figures were given on a 220-kv air-blast switch showing clearing times of 4 to $5^1/_2$ cycles on an older design and 4 cycles on the new design. The air pressure had been increased to 150 pounds per square inch and the discusser believed there might be some advantage in going to higher pressures. Selection of materials and treating of air had presented some problems originally in the design of this high-voltage switch which was operating in a cold climate. The discussion further brought out the fact that one manufacturer believed that higher pressures gave greater margins at very little cost and that these higher pressures were used for this reason. The air paths presented very little resistance to air flow compared with the blast valve, according to one manufacturer, while another thought that a lot of air not limited by air-flow paths was desirable. The latter manufacturer proposed to keep the quantity of air to a minimum by having well-timed valves. (*A. C. Monteith, secretary, committee on protective devices.*)

Standards Session and Conference

The Standards session and conference on January 27, during the AIEE 1942 winter convention under the chairmanship of R. T. Henry, drew an attendance of 65. The first paper dealt with hot-spot winding temperatures in self-cooled oil-insulated transformers, and was presented by Paul Narbutovskih, co-author with F. J. Vogel, both of Westinghouse Electric and Manufacturing Company (see *Transactions* pages 133–6). He showed by test data and calculations that the temperature rise of the hot spot of the winding above the top oil does not increase with load, as previously supposed, because the decreased oil viscosity and consequent more rapid oil circulation fully offset the increased losses. This relationship simplifies the calculation of overload temperatures and suggests that higher emergency loading may be permissible than the recommended practices of the American Standards Association. Figures given in the paper, in terms of rated load current, are 2.1, 1.90, and 1.71 for the safe emergency loading periods of one-half, one, and two hours, respectively; these compare with figures of 1.6, 1.38, and 1.25 given in Figure 17, page 86, of the ASA recommended practices.

Several discussers thought that the suggested overloads were too high, and pointed out various differences in the assumptions used and the construction employed, from those applying to other transformers.

The second paper, by R. E. Hellmund and P. H. McAuley of the Westinghouse company dealt with the effects of ambient-temperature variations on the application of electrical apparatus. Data were given on the percentages of time that various ambient temperatures exist in different localities, and on the equivalent average ambient temperature calculated on the basis of the eight-degree-centigrade rule for half insulation life. From these data, the percentages of applications for which standard apparatus is suitable were given.

The third item on the program was the re-presentation by P. L. Alger of AIEE Standards Pamphlet No. 1A, a report on general principles for rating of electrical apparatus for short time, intermittent, or varying duty. This report was summarized in an article appearing in the December 1941 issue of *Electrical Engineering* (pages 569–71), and is of especial present interest because of its bearing on the use of smaller or higher-temperature-rise apparatus for emergency purposes. The essential feature of the report is the suggestion that apparatus intended for intermittent or short-time duty be given a dual rating; the name-plate rating would indicate the torque ability, or "strength," of the apparatus, and a less-than-unity service-factor multiplier would indicate the continuous rating, or "endurance," of the apparatus. For example, it was suggested that short-time-rated motors, now used in a limited number of applications, will find more general use if the name-plate includes a service-factor multiplier, showing the permissible continuous loading. Such a motor, having a torque value indicated by the name-plate horsepower, and an endurance rating indicated by the service-factor multiplier, may be more intelligently applied to all sorts of intermittent-duty cycles or short-life applications than if only a single horsepower value is given.

The main purpose of the report, therefore, is to make available a more convenient "handle" by which familiar types of apparatus can be effectively applied. Under the present emergency conditions, where materials must be conserved in every possible way, and where many applications require light-weight or relatively short life expectancy, the rating methods given in the report should be especially useful.

In the discussion, a letter was read from Thomas Carter, of A. Reyrolle and Company, Ltd., England, commenting favorably on the report, and saying that the same ideas of service-factor rating are being considered in British standards.

The final paper on the program was a discussion of the thermal co-ordination of low-voltage a-c circuits, presented by B. W. Jones. The problem here is to match the thermal time constants or rates of temperature rise on motors, relays, wiring, and fuses so that protection will be afforded under all conditions without waste in the use of materials. Mr. Jones showed that balanced protection is secured in the typical case of a motor having a full-load current density in the copper of 3,000 amperes per square inch, if the corresponding current density in the smallest cross section of the zinc fuse wire is also 3,000 amperes per square inch, and in the Nichrome heater of the relay is 1,370 amperes per square inch. These relations of cross section of the copper, zinc, and Nichrome, in the ratios of 1, 1, and 2.2, insure that under short circuit conditions the fuse will clear just as the Nichrome reaches its limiting safe temperature of 1,350 degrees centigrade, and the copper reaches a temperature of 125 degrees centigrade, assuming normal initial load and ambient temperatures. In deriving these values, it is assumed that the time for the fuse to melt is just one third the total time required to clear, and that the rms current during the fuse arcing period after the melting is 58 per cent of the value existing at the instant of melting.

Mr. Jones also pointed out that the current-limiting effect of the fuse enables it to clear the circuit in a small fraction of a half cycle, at least for fuses rated 200 amperes and below. Small-sized fuses are, therefore, much faster than circuit breakers, and it is essential that they be used rather than breakers alone, if full protection against short-circuit damage to relays and other apparatus is to be secured.

This whole subject of thermal co-ordination of apparatus, and protective devices on low-voltage circuits, is rapidly assuming an importance comparable with that of insulation co-ordination of high-voltage circuits exposed to lightning. The use of built-in thermal protective devices on small motors is proving of great benefit in protecting them from damage under stalled conditions. Also, the use of time-lag fuses permits higher motor-starting currents up to the limits of allowable voltage flicker without increase in the size of wiring. Further, the careful selection of fuse ratings, and in some cases the use of reclosing fuses, for distribution circuits, are providing more reliable service on branch lines and feeders by lessening the time and extent of service interruptions. However, all these various developments must be fitted into a general plan of rating and selection with respect to time-current-temperature characteristics. By so doing, fewer varieties of lower-cost equipments can be used, and maximum economies can be effected in the system as a whole. (*P. L. Alger, vice-chairman, standards committee.*)

Session and Conference on Domestic and Commercial Applications

A combined session and conference was held Tuesday afternoon, January 27, under auspices of the committee on domestic and commercial applications, with Alexander Maxwell, chairman of the committee, pre-

siding. A technical paper on "Utilization Voltages" was presented by H. P. Seelye, Detroit Edison Company, which appears in the *Transactions* section, pages 147–51. It was followed by prepared discussion (which will appear in due course in the *Transactions*), concerned to a large extent with the consideration of whether standardization of a utilization voltage range is feasible or desirable at present.

In addition, S. G. Hibben of the Westinghouse lamp division, Westinghouse Electric and Manufacturing Company, Bloomfield, N. J., emphasized the desirability of industry-wide standardization of the terminology used to the public, calling attention to the confusion created in the minds of users by 120-volt lamps, 115-volt ranges, 110-volt motors. He urged agreement on a voltage range for design purposes, which should of course be as narrow as possible and the selection of a nominal central point of that spread to be used in describing apparatus for the public, pointing out that unless the industry arrived at some such agreement, it might have one imposed by the Federal Government, since the War Department is already looking askance at duplication of equipment stocks which use essential metals. He also suggested attention to extending the use of the standard voltage-range and terminology to Canada and the other American countries. He referred to the importance of stressing the adequacy of customers' wiring, since the voltage drop at that point is a significant factor in determining the standard range of utilization voltage. Feature of the conference was a paper by Carl F. Scott, General Electric Company, Bridgeport, Conn., which suggested as a program for the work of the committee, looking to the needs of the postwar period, an analysis of the factors influencing the design of domestic appliances; the development of standards of performance based on such study; and a program to educate the public to the standard of performance it may reasonably expect.

He listed a number of factors influencing appliance design, but called attention to the fact that no study to date shows the degree to which each factor affects the design of a particular appliance. Although the committee cannot actually set up standards, it can set objectives for the design and performance of each type of appliance, which will be above the present commercial average but realizable in the present state of the art, he said. He emphasized the importance of public education, pointing out the public is often willing to pay for better performance when aware that such can be obtained. While market surveys ordinarily precede product design, sometimes the design comes first and the demand is developed later, he pointed out, citing the electric shaver as an example. The design of consumer appliances is usually not scientific, being based on considerations of past practice, supposed purchasing habits, and price, rather than on maximum efficiency. Use of a more scientific procedure would make it unnecessary "to use the customer as a laboratory" to the extent that occurs at present, Mr. Scott said.

L. A. S. Wood, chief lighting engineer, Westinghouse Electric and Manufacturing Company, Cleveland, Ohio, spoke on the relation of street and highway lighting to national defense, emphasizing the importance of traffic safety.

Session on System Switching

System switching was the topic of a session held January 27, during the AIEE 1942 winter convention, under joint sponsorship of the committees on protective devices, and transmission and distribution. Jointly presiding were J. R. North and Philip Sporn, respective chairmen of the two committees.

The first three papers were: "High-Speed Single-Pole Reclosing," by J. J. Trainor, Public Service Company of Indiana, Indianapolis, J. E. Hobson, Illinois Institute of Technology, Chicago, and H. N. Muller, Jr., Westinghouse company, East Pittsburgh, Pa., February 1942 *Transactions* section, pages 81–87; "Relays and Breakers for High-Speed Single-Pole Tripping and Reclosing," by S. L. Goldsborough and A. W. Hill, Westinghouse company, Newark, N. J., February 1942 *Transactions* section, pages 77–80; and "Analysis of the Application of High-Speed Reclosing Breakers to Transmission Systems," by S. B. Crary, L. F. Kennedy, and C. A. Woodrow, General Electric Company, Schenectady, N. Y. These papers dealt with data and studies on reclosing schemes as applied to American systems. Tests on one type of installation were presented and the results of theoretical studies were made available. One discusser questioned the use of 50 per cent greater deionizing time for single-pole reclosing as compared with gang operation. He stated that this was a function of line length. The authors concurred in this but thought that it was not important in the over-all problem.

Another discusser questioned the use of single-pole versus three-pole operation. He thought systems should be designed for the worst practical condition which was for a fault involving two lines and ground. He further believed that single-pole reclosing should simply be considered another scheme and should receive full appraisal with existing methods before a system was selected. The authors concurred, but believed that single-pole reclosing presented some attractive advantages in some instances.

Another discusser thought that single-pole reclosing would reduce shock to the system, as the majority of faults are single-phase-to-ground, particularly on steel-pole lines. He also believed that it gave a margin for emergency transmission of power above the normal design limit that would exist with gang operation of breakers.

The general opinion was that this was another method of switching that should receive full recognition. It was not comparable, one discusser believed, with ground-fault neutralizers in one main respect, namely that neutralizers can be used only on free-neutral systems requiring full insulation, while single-pole reclosing can be used on grounded-neutral systems giving protection for the single-phase faults on such a system. The relaying for single-pole reclosing presented a problem, but the discussions brought out the point that methods of relaying were available for single-pole reclosing for a wide variety of system setups.

The last two papers, "Relative Value of Different Types of Overcurrent Protection for Distribution Circuits," by G. F. Lincks, General Electric Company, Pittsfield, Mass., January 1942 *Transactions* section, pages 19–25; and "Performance of Ground Relayed Distribution Circuits During Faults to Ground," by C. L. Gilkeson, Virginia Electric and Power Company, Richmond, and P. A. Jeanne and J. C. Davenport, Jr., Bell Telephone Laboratories, New York, N. Y., January 1942 *Transactions* section, pages 40–48, contained data and studies of fault clearing on distribution systems. In discussion, it was pointed out that everything should be done to get service to customers with a minimum of material. One discusser cited the fact that the use of radial feeders with reclosing produced good results were formerly loop feeds had been used. He outlined tests that indicated the soundness of this method of power supply. Such practice, however, sometimes necessitates changes in industrial controllers to hold them in during the reclosing period. Joint use of poles with the Bell System has further resulted in economies. It was also pointed out that the fuse was now a reliable device with good time characteristics and should receive its full consideration. Care should be exercised to use all modern devices having similar characteristics where close timing is desired. One discusser believed there should be more fuse papers of the type presented to stimulate consideration of fuses and achieve standardization. The value of co-operative studies between the utilities and communication companies, as pointed out in the last paper, was confirmed by a number of discussers. (*A. C. Monteith, secretary, committee on protective devices.*)

Symposium on Asynchronous Machinery

Five papers were presented at the symposium on asynchronous machinery held January 29 during the AIEE 1942 winter convention. Presiding jointly were: C. M. Gilt, chairman, committee on electrical machinery; E. E. Minor, chairman, committee on air transportation; and J. J. Orr, chairman, committee on industrial power applications.

The first two papers described installation of electric drive for wind tunnels for testing small and full-scale airplanes and parts of airplanes; these were: "Variable-Speed Drive for U. S. Army Air Corps Wind Tunnel at Wright Field," by A. M. Dickey, U. S. Army Air Corps, and C. M. Laffoon and L. A. Kilgore, Westinghouse Electric and Manufacturing Company; and "Large Adjustable-Speed Wind-Tunnel Drive," by C. C. Clymer, General Electric Company. For this work wind velocities are required up to 400 to 600 miles per hour requiring power supply up to

40,000 horsepower. A large part of the testing is done at velocities much lower than the maximum and the lower velocities are obtained by reduced-speed operation of the motor drive for the propeller fans. The variable speed is obtained by providing a slip-ring motor for the main driving source with adjustable frequency applied to the slip rings. The adjustable frequency is obtained from a motor generator set with d-c motor drive and a synchronous generator coupled electrically to the rings of the induction motor. The d-c motor supply is obtained from d-c generators with constant-speed motor drive. By this method of drive the proper voltage and frequency can be supplied to the rings of the induction motor, materially reducing the losses as compared to those which would result from resistance control of induction motors. The power factor can be readily kept within approximately 90 per cent lagging and the drive is stable with very close limits of speed control over the entire range. This method of control also provides a convenient means of starting without excessive starting current requirements.

The next two papers were: "A Study of the Modified Kramer or Asynchronous-Synchronous Cascade Variable Speed Drive," by M. M. Liwschitz, The Polytechnic Institute of Brooklyn, and L. A. Kilgore, Westinghouse Electric and Manufacturing Company; "The Doubly Fed Machine," by C. Concordia, S. B. Crary, and Gabriel Kron of the General Electric Company. These papers analyze the electrical characteristics of the motor and its control with particular regard to stability, and provide methods of calculating the characteristics.

The final paper, "Equivalent Circuits for the Hunting of Electrical Machinery," by Gabriel Kron of the General Electric Company, develops equivalent circuits for electrical machines, with particular regard to hunting and stability. It develops methods for electric motors in general and is adaptable to the doubly fed machine. The establishment of these equivalent circuits makes possible the use of a system analyzer with mechanical solution of the circuits and consequently, the characteristics of the equipment. During the discussion the question was raised as to the value of such methods of calculation as a means of teaching undergraduate students. It was recognized that the students must be given a good physical concept of the performance and characteristics of machines and that the development of equivalent circuits and other short-cut methods furnish convenient tools for determination of the characteristics of machines. The session added material knowledge of the characteristics of asynchronous machinery as well as convenient tools for predetermination of their performance. (*Carl M. Gilt, chairman, AIEE committee on electrical machinery.*)

Session on Lightning Arresters and Protection

The first paper presented at this session of the AIEE 1942 winter convention was "Back-Up Protection of the Boulder Dam–City of Los Angeles Transmission Line," by C. P. Garman (City of Los Angeles) and L. F. Kennedy (General Electric Company). This paper discusses the requirements of a back-up protection system as regards both the type of failure and the arrangement of system connections. In the discussion, E. H. Bancker (General Electric Company) pointed out that while the title of the paper indicated that the material applied to a specific system, actually the general principles were more general.

The second paper presented was entitled "Temperature and Electric Stress in Impregnated Paper Insulation," by J. B. Whitehead and W. H. MacWilliams, Jr., Johns Hopkins University (January 1942 *Transactions* section, pages 10–13). The discussion by Herman Halperin (Commonwealth Edison Company) pointed out that he had made tests on cables at temperatures up to 100 degrees centigrade and stresses as high as 294 volts per mil for much longer periods of time than used by the authors without observing rapid power factor increases; also, that usually more than a year is required before the power factor increases appreciably due to the presence of some oxygen in the oil. W. A. Del Mar (Phelps Dodge Corporation), pointed out that in cable testing the temperature is carried through cycles and the effect may be different from that when the temperature is held constant. R. J. Wiseman (Okonite-Callender Cable Company) suggested that perhaps the word, "dissociation," is not used in the usual sense. He further stated that electrolytic dissociation is usually temporary and not permanent, as is the effect noted by the authors. L. J. Berberich (Westinghouse research laboratories) stated that the effect observed by the authors can be explained easily on the basis of gaseous ionization provided it is possible for gas pockets to form within the insulation. He pointed out that the evidence for gas-pocket formation would probably be difficult to find in the short-time tests made by the authors. He suggested that a lower viscosity oil should be investigated. Both H. H. Race (General Electric Company) and R. W. Atkinson (General Cable Corporation) expressed the idea that the observed power-factor increase may be due to oxidation taking place in the bath oil which was exposed to air. Doctor Whitehead, in replying, stated that the paper is not to be regarded as a completed research, but the results achieved so far seemed startling enough to warrant publication. He further stated that it is not necessarily a contradiction of his work and that done on cables, because conditions are different. He also stated no evidence of internal gaseous ionization was observed in any of his specimens.

The third paper was presented by H. W. Collins (Detroit Edison Company), chairman of the lightning arrester subcommittee, who gave the report of the subcommittee, entitled "Distribution-Type Lightning Arrester Performance Characteristics" (*Transactions* page 132). There was no discussion.

The fourth paper presented was entitled "Field Investigation of the Characteristics of Lightning Currents Discharged by Arresters," by I. W. Gross (American Gas and Electric Service Corporation), and G. D. McCann and Edward Beck (both of the Westinghouse Company). In comparing Figures 3 and 9 of the paper, W. J. Rudge (General Electric Company) suggested that the difference might be attributable to instrument sensitivity. E. R. Whitehead (Duquesne Light Company) stated that the slow rates of rise so far measured explain the highly satisfactory over-all performance of modern lightning arresters, but suggested that continued investigations might reveal higher rates of rise for measurements close to stroke locations. H. A. P. Langstaff (West Penn Power Company) presented data collected on West Penn system, in co-operation with the Westinghouse company, for an arrester discharge of 11,000 amperes and a rate of rise of 7,340 amperes per microsecond, the highest measured rate of rise to date.

J. R. North, chairman, committee on protective devices, and C. F. Wagner presided jointly at this session. (*C. F. Wagner, chairman, general systems subcommittee, committee on power transmission and distribution.*)

Session on Electrical Machinery

At the technical session on electrical machinery held January 26 during winter-convention week, five papers were presented. Carl M. Gilt, chairman, AIEE committee on electrical machinery, presided.

"Progress Report of D-C Testing of Generators in the Field," by E. R. Davis and M. F. Leftwich of the Duke Power Company, was the first paper presented. This is an interesting and valuable contribution to our knowledge of the testing of electric generators and is supplementary to the report presented on the testing of generators at the 1941 AIEE winter convention. The Duke Power Company has had considerable success in discovering incipient faults in generators by the use of direct current and periodic testing. The company has progressed in steps starting at lower voltages and later working up to voltage as high as 14,000, d-c. A regular test procedure and schedule of test voltage to be applied to machines of different ratings have been established.

Three papers by T. C. McFarland, University of California, presented mathematical methods of calculating the characteristics of transformers, generators, and capacitor motors.

The last paper, "Resistance Welding Transients," by E. E. Kimberly, Ohio State University, resulted from an investigation to determine the erratic behavior in welding thin materials such as aluminum skin on airplane wings. This was traced to transients that arise when the switch is closed applying the welding current which may affect the weld when the duration of the welding current is very short, such as a few cycles. The effect of the transients is reduced or practically eliminated when the welds are of longer duration. The transients

are found to be of less magnitude when the switching is on the secondary of the welding transformer, but this type of control is not for general commercial use and it is more difficult to apply than primary switching. (*Carl M. Gilt, chairman, committee on electrical machinery.*)

Air Transportation Session and Conference

A session and conference on air transportation was held January 29, during the AIEE 1942 winter conventions, and was attended by more than 160 members of the Institute who previously submitted a statement of United States citizenship. E. E. Minor, chairman of the committee on air transportation, presided. It was necessary to restrict the attendance of this meeting to American citizens because of the close relationship of the papers and some aspects of the war program. The meeting was restricted to a presentation of the four scheduled papers, and discussion was limited to matters not connected with national defense.

The meeting showed considerable interest in the activities of the air-transportation committee and led to spirited discussions which have not been prepared in written form because of the necessity for clearances of such discussion from the War Department before publication. The method of restricting attendance to the meeting was very successful and did not lead to any hardships or ill feelings on the part of the members.

One of the four papers has now been released for publication in AIEE *Transactions;* release of the other three by the War Department is expected later. (*E. E. Minor, chairman, committee on air transportation.*)

Conference on Arc-Back in Mercury-Arc Rectifiers

At the conference on arc-back in mercury-arc rectifiers, held January 30, 1942, during the AIEE winter convention, the discussion was opened by J. H. Cox of the Westinghouse Electric and Manufacturing Company who stressed the engineering and economic aspects of the subject and by Professor B. K. Northrop of Cornell University who laid emphasis on the physical bases of the phenomenon.

Arc-backs can be objectionable because of the shock to which the large current surge subjects the transformers and the injurious effect of the arc-back on the rectifier itself. Both these results are minimized by the use of circuit breakers placed in the cathode lead, the transformer primaries, or the individual anode circuits. Fast circuit breakers will interrupt the short-circuit currents before they have built up to excessive magnitudes, and the maintenance of these breakers represents a major economic cost of arc-backs. Deionizing grids reduce the arc-back rate but increase arc drop and so decrease efficiency. An attempt to assess these opposing factors in economic terms provides ground for interesting speculation.

Discussion on the physical causes of arc-back showed that while much work remains to be done, great progress has been made in understanding this puzzling phenomenon. Most arc-backs occur immediately following commutation, and there has come to be rather general agreement that they are often associated with impurities in the rectifier. There is good evidence that small insulating particles of approximately 10^{-6} centimeter in diameter can cause arc-back if present on the anode surface. These insulating particles are charged positively by the ionization present in the neighborhood of the anode during deionization, and the resulting high electric gradients release electrons from the anode surface by the process of field emission. Since ion density at commutation is an important factor, the circuit constants, which determine both the rate of change of current and the magnitude of the applied inverse voltage at this point in the cycle, are also important in their influence on the arc-back rate.

Those contributing to the discussion included: J. H. Cox and D. E. Marshall, Westinghouse Electric and Manufacturing Company; C. C. Herskind, E. J. Lawton, L. W. Morton, and H. C. Steiner, General Electric Company; O. K. Marti, Allis-Chalmers Company; J. T. Thwaites, Canadian Westinghouse Company; B. K. Northrop, Cornell University; C. H. Willis, Princeton University; D. L. Waidelich, University of Missouri; D. V. Edwards, Electrons, Inc.; and others. About 50 persons attended the conference. (*S. B. Ingram, chairman of the conference.*)

Session on Industrial Power Applications

The industrial power applications session was one of the best attended sessions of the convention. The paper "The Fundamentals of Industrial Distribution Systems" by D. L. Beeman and R. H. Kaufmann (General Electric Company) proved especially interesting to a large number of those present. This was proved by the unusual number of discussers. There was some difference of opinion among the discussers, chiefly concerning the relative merits of the "selective-secondary system" and the "secondary-network system" for the majority of factory power-distribution systems. The authors and several of the discussers were careful to point out that no single type of system would be found suitable for all problems.

The session was preceded by a luncheon meeting of the industrial power applications committee. The subject of the desirability of industrial groups in AIEE Sections was discussed. The chairman reported that such a group had been formed in the Detroit Section this year and had proved very successful so far. Over 200 attended the first session in November 1941. It was decided that a subcommittee should be appointed to foster the formation of these groups in such Sections as appeared desirable. Some consideration was also given to the desirability of a committee report on progress in the field of industrial power applications. It is expected that some action on this will be taken at a later date. Members of the committee were invited to express any ideas or opinions they may have. (*J. J. Orr, chairman, committee on industrial power applications.*)

Session on Protective Relays

One of three sessions sponsored by the AIEE committee on protective devices during the 1942 winter convention was devoted to the subject of protective relays. J. R. North, chairman of the committee, presided.

The first paper, "Multichannel Carrier-Current Facilities for a Power Line" by P. N. Sandstrom and G. E. Foster (February 1942 *Transactions* section, pages 71–6) described a complete system of carrier-current channels for the control and relaying of a line. In the discussion of this paper the authors pointed out that their scheme did not provide out-of-step blocking and that they had not made a study for the three terminal applications.

The next paper, "Loss-of-Field Protection for Generators," by R. L. Webb, H. F. Lindemuth, and G. C. Crossman, Consolidated Edison Company of New York, outlined the desirability of a loss-of-field relay for large generators, described a relay system for a large generator and presented tests and calculations to show that the plan is practical. Recently the scheme tripped a machine correctly, making field experience available.

During the discussion the difficulty of setting up operating rules to clear a machine on loss of field was pointed out. One discusser did not consider it necessary to trip a hydroelectric machine if it were carrying low load, and believed it more advisable to reduce load than to open the field, in which case the machine would resynchronize itself. Another discusser thought that the scheme set forth in the paper was practical in this case as the application was made for a metropolitan power system. He pointed out that there were two main problems in protecting a machine on a bus, the first, tripping the machine for internal short circuit, having been solved for some years by various differential schemes, and the second, loss of field, covered by this paper. The general opinion was that this was a contribution to the art provided the limitations of application were recognized.

"Transient Characteristics of Current Transformers During Faults," by C. Concordia and H. S. Shott, General Electric Company, and C. N. Weygandt, University of Pennsylvania, dealt with the transient characteristics of different transformer combinations used for differential relaying. Calculations were made on the University of Pennsylvania analyzer. One discusser did not consider that the size constant was an effective method of dealing with the transient characteristics of current transformers, pointing out that there were bus differential schemes in operation using a percentage differential relay with standard current transformers.

The fourth paper, "Current Transformer Performance Based on Admittance-Vector Locus," by A. C. Schwager, Pacific Electric Manufacturing Corporation (January 1942 *Transactions* section, pages 26–30), described a method of giving complete current-transformer information as a result of which the complete power-factor or phase-angle information for any rating of a multiratio current transformer can be plotted on one curve. In discussion it was agreed that the method outlined in this paper was a contribution which should receive consideration with other methods for the standardization of the characteristics of current transformers on a more simplified basis.

The last paper, "Linear Couplers for Bus Protection," by E. L. Harder, E. H. Klemmer, W. K. Sonnemann, and E. C. Wentz, Westinghouse company, dealt with a new form of bus protection using linear couplers without iron which eliminates the problems of saturation. During the discussion the question was raised as to whether or not the settings for the scheme were being made too close for practical application. One discusser thought that the gap type of current transformer was preferable because it allowed a high power level for operating the relays. It was thought that 1.5 per cent effect from external fields was high compared with air-gap transformers. The authors indicated that this factor included not only the effect of stray fields but all possible sources of error, such as manufacturing tolerances and effect of position of inner and outer conductors. It was generally believed that this scheme merited consideration in making a bus differential application. (*A. C. Monteith, secretary, committee on protective devices.*)

Instruments and Measurements Session

Approximately 100 persons attended the session on instruments and measurements held Friday afternoon January 30 during the AIEE 1942 winter convention. F. B. Silsbee, chairman of the committee on instruments and measurements, presided.

The first paper, "The Measurement of Maximum Demand" (February 1942 *Transactions* section, pages 57–62), continued in amicable fashion the long and sometimes bitter argument, now over a quarter of a century old, as to the relative merits of the two basic types of demand meters, thermal and block-interval. The author, AIEE Past President P. M. Lincoln, spoke for the former, while W. J. McLachlan (General Electric Company) in his discussion pointed out the good features of the latter.

The discussion of the second paper "The Acceleration-Oscillogram Method of Motor-Torque Measurements," by C. R. Atkinson and G. D. Downie, General Electric Company (January 1942 *Transactions* section, pages 7–9), began from the point of view of a report on improved testing methods, but shifted to a discussion of the performance characteristics of a-c motors during the starting period. In this discussion professors from four leading colleges took part.

A. J. Corson (co-author with R. M. Rowell and S. C. Hoare, all of General Electric Company) presented the outstanding features of the new types of switchboard instruments recently designed by himself and his colleagues, in a paper "Design of Long-Scale Indicating Instruments." These are characterized by the unusually large angular deflection of 240 degrees for full scale, thus securing a long length of scale and a small instrument.

M. A. Princi (co-author with E. E. Lynch, both of General Electric Company) in a paper "Improvement in Modern Meter-Testing Technique," described the very elaborate automatic testing equipment that has been developed as a logical consequence of applying to the adjustment and testing of watt-hour meters in the factory the same basic principles of mass production originally developed by the automobile industry. (*F. B. Silsbee, chairman, committee on instruments and measurements.*)

Sections Committee Meets

An informal meeting of the AIEE sections committee was held January 27, 1942, during winter-convention week. Chairman Coover announced that the remaining unassigned territory in Districts 2 and 6 has been allocated to the appropriate Sections. With the approval of the recommendation thereon by the board of directors, unassigned AIEE territory within the continental United States becomes an item of Institute history.

It was announced also that reports on meetings received from Section officers reflect wide interest in the talks given by President D. C. Prince and others on postwar rehabilitation plans. The suggestion of the Sections committee and of the technical program committee that the Sections broaden the scope of their local activities to include regular programs or forums on subjects of nontechnical interest, particularly civic affairs, has been well received. Many Sections report that such meetings are being held with satisfactory results.

Progress is reported by some Sections on student-guidance work, with special committees assigned to arrange for speakers when requested by the local high schools and to assist the schools when help in student-guidance work is desired. In one Section this committee also works toward encouraging greater interest of college students in Section Activities, through special "Student Night" programs, participation of Section officers in Branch programs, and subsidizing of luncheons and dinners for students to induce them to attend Section meetings.

Chairman Coover called attention to the need, pointed out by the AIEE membership committee, for the Sections to devise means of arousing greater interest among older members in Institute work. In many cases the interest of the younger members of an organization is influenced by the interest of those higher up in that organization. Active local transfer committees have assisted some Sections in stimulating eligible members to transfer to the higher grades.

A number of Sections have been helped in preparing meeting notices by receiving sample notices from other Sections. It was suggested that each Section send a copy of its first meeting notice of each fiscal year to every other Section. This will provide each Section, early in the season, with excellent material from which ideas for improvements in meeting notices can be obtained.

A gratifying increase in local publicity is noted from the increased number of newspaper clippings received by Chairman Coover with reports of Section meetings. Smaller Sections report little trouble in obtaining newspaper publicity, but the larger Sections appear to have some difficulty in having meeting programs reported regularly.

Reports of meetings indicate an increase in joint meetings among AIEE Sections and between AIEE Sections and those of other societies. In general, experience with these joint meetings has been satisfactory. (*W. B. Morton, vice-chairman and secretary, Sections committee.*)

DISTRICT • • • • •

Arrangements Progressing for North Eastern District Meeting

A good program is in prospect for the North Eastern District meeting and Student Branch convention, to be held in Schenectady, N. Y., April 29–May 1, 1942, with headquarters in the Van Curler Hotel. As arrangements progress, it appears almost certain that the war will cause no curtailment of the program.

At the opening session well-known speakers will discuss the subjects of electrical research and electrical engineering during wartime and in the readjustment to follow. In the afternoon of the first day, in addition to a technical session, there will be a conference and inspection trip dealing with mercury power-plant operation and maintenance. In the evening a dinner and smoker will be held, featuring entertainment of an unusual character.

The technical sessions on April 30 precede and follow a luncheon and conference at which Professor W. H. Timbie of Massachusetts Institute of Technology will preside, vocational education will be the topic of the conference. Addresses will be delivered by Lewis A. Wilson, Deputy Commissioner of Education for New York State; Alonzo Grace, Commissioner of Education, State of Connecticut; and C. E. Crofoot, Mount Pleasant High School, Schenectady, N. Y. In the evening, the 15th Steinmetz Memorial Lecture will be given. This lecture, made possible by the Steinmetz Memorial Foundation, is arranged by the Schenectady Section, AIEE. It is delivered annually by a speaker noted for achievement in one of the professional or scientific fields.

On Friday, May 1, a student session is to be held which should be worth while notwithstanding the upset in college schedules caused by the war. Following

the session there will be a luncheon for the students, which will be addressed by an industrial leader interested in the employment and development of engineering graduates. The dinner-dance that evening will be featured by brief talks by outstanding guests.

SECTION • • • • •

Practical Limits to Illumination Levels

In recognition of the fact that there is a direct relationship between human efficiency and the level of available illumination, and the especial importance of maximum industrial efficiency incidental to the current war efforts, considerable attention is being given to illumination studies. These studies have had to do with both the development of new systems for new plants and the conversion and improvement of old systems in old plants.

At a recent joint meeting of the New York Section of the Illuminating Engineering Society and the Illumination Group of the New York Section of the AIEE, Henry Logan of the Holophane Company discussed the equipment requirements for, and the several limiting factors involved in, the installations required to produce effective illumination ranging from 100 to 1,000 foot-candles. Six limiting factors were mentioned and discussed: equipment limitations, operating limitations, brightness "ceiling," job conditions, invisible radiation "ceiling," and cost. Mr. Logan stressed the point that although present-day technical achievements would enable a maximum of some 4,800 foot-candles of illumination on a horizontal plane, the combined effects of the foregoing factors would be to interpose a practical limit of probably about 100 foot-candles of horizontal illumination "for some time to come."

The effect of equipment limitation is obvious; only so many lamps or fixtures can be given physical accommodation on any given ceiling area. Any maximum physical concentration would involve operating limitations embracing questions of luminous efficiency caused by the massing, as well as depreciation, deterioration, and fire hazard from the heat involved. Also, such high concentrations would raise brightness difficulties that would be as distressing to the eyes as a brilliant midday summer sky. The job conditions would embrace such factors as the reflectivity of walls, floors, and equipment. The invisible radiation from such a massing of lighting equipment is one of two major controlling factors. According to authorities, discomfort caused by the accompanying invisible radiation from incandescent lamps begins to be felt at a level of 125 foot-candles. Levels above 750 foot-candles for incandescent and 3,000 for fluorescent probably would require year-round refrigerated air conditioning, and would contribute infrared radiation at the same rate that nature does in the month of July (in New York City) when daylight averages 5,500 foot-candles. Cost—a limit set by the economic relation of lighting to its benefits—is one of the two major factors. Cost is a flexible limit, and one affected by local conditions, but in general the cost factor is the item which above all others influences lighting installations downward to their lowest level of effective illumination. A lighting cost representing about two per cent of over-all production cost was mentioned by Mr. Logan.

A summary of the various practical limits suggested by Mr. Logan is given in the accompanying tabulation. Mr. Logan warned that these figures represent "broad generalizations that may fall down in any particular application," but submitted them for purposes of discussion and further consideration of an important matter.

Present Practical Limits to Artificial Illumination As Set by Various Controlling Factors*

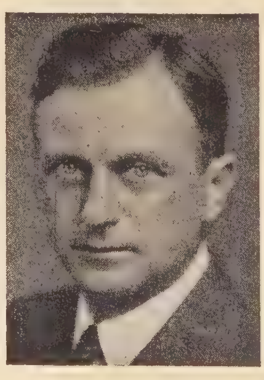
Controlling Factors	Incandescent Lamps	40-Watt Fluorescent Lamps	100-Watt Fluorescent Lamps	400-Watt Mercury Lamps	3,000-Watt Mercury Lamps
Equipment limitations	1,900 FC 160 W	850 FC 40 W	1,450 FC 60 W	1,800 FC 90 W	4,800 FC 200 W
Operating limitations	1,900 FC 160 W	700 FC 30 W	750 FC 30 W	1,800 FC 90 W	750 EC 30 W
Brightness	1,200 FC 111 W	1,200 FC 70 W	1,200 FC 70 W		
Job conditions	600–1,900 FC 160 W	400–1,200 FC 70 W	500–1,450 FC 60 W	600–1,800 FC 90 W	1,600–4,800 FC 200 W
Radiation ceiling Without air conditioning	125 FC 10.5 W	400–500 FC 13–17 W	400–500 FC 13–17 W	175 FC 8 W	400–500 FC 13–17 W
Cost	50 FC 4.5 W	125 FC 4.5 W	125 FC 4.5 W	90 FC 4.5 W	125 FC 4.5 W

* "FC" represents horizontal foot-candles; "W" represents watts per square foot.

PERSONAL • • • •

H. S. Osborne Nominated for Institute President

Harold Smith Osborne (A'10, M'15, F'21) plant engineer, operation and engineering department, American Telephone and Telegraph Company, New York, N. Y., has been nominated to serve as AIEE president for 1942–43. He was born August 1, 1887 at Fayetteville, N. Y., and received from Massachusetts Institute of Technology the degrees of bachelor of science in 1908 and doctor of engineering in 1910. He joined the American Telephone and Telegraph Company in 1910 as engineer in the transmission and protection department, became assistant to the transmission and protection engineer in 1914, and transmission engineer in 1920. In 1939 he was appointed operating results engineer and the following year, plant engineer. He is currently serving as a director of the Institute, chairman of the finance committee, and a member of the executive, headquarters, planning and co-ordination, Institute policy, and Edison Medal committees, and as AIEE representative on the Alfred Noble prize committee. He has served on the standards committee (chairman 1923–26), communication committee (chairman 1931–34), technical program committee (1936–39), and award of Institute prizes (chairman 1936–39), and on the committees on education, publication, legislation affecting the engineering profession, and several special committees. He has also served as AIEE representative on the American Association for the Advancement of Science. He recently was elected chairman of the Standards Council of the American Standards Association, having been AIEE representative or alternate on the Council since 1923, and since 1932, a representative on the electrical standards committee of the ASA. He is also vice-



H. S. Osborne

K. B. McEachron

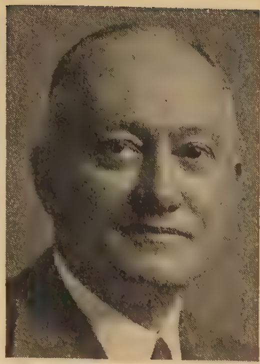
C. R. Jones

president and treasurer of the United States National Committee of the International Electrotechnical Commission on which his service as Institute representative also dates from 1923. He is the author of a number of articles on technical subjects.

Vice-Presidential Nominees Are McEachron, Jones, Mahood, Schilling, and Dewars

Karl Boyer McEachron (A'14, M'20, F'37) research engineer, high-voltage practice, General Electric Company, Pittsfield, Mass., has been nominated for vice-president of the AIEE North Eastern District (1). He was born November 17, 1889 at Hoosick Falls, N. Y., and received the degrees of electrical engineer from Ohio Northern University in 1913, master of science from Purdue University in 1920. He received the honorary degrees of doctor of engineering from the former in 1938 and doctor of science from the latter in 1941. In 1913 he became test engineer for the General Electric Company, Pittsfield, Mass., and during the next four years was instructor in electrical engineering at Ohio Northern University, Ada. From 1918 to 1922 he was instructor of electrical engineering and research associate in the engineering experiment station, Purdue University, Lafayette, Ind. He joined the General Electric Company again in 1922 to take charge of the research and development section of the lightning-arrester department and in 1933 was appointed to his present position. He was a director of the Institute 1936–40 and has served on the following committees: basic sciences (formerly electrophysics), Edison Medal, technical program, executive, and legislation affecting the engineering profession. He is currently serving as a member of the committee on protective devices (chairman 1938–40) and the standards committee. He has received a Coffin award and the Longstreth Medal of the Franklin Institute for his part in the development of the insulating material, Thyrite, and in 1941 he was the recipient of the B. F. Goodrich award for distinguished public service. He is also the author of a number of technical articles relating to high-voltage phenomena and lightning arresters, and co-author of a book, "Playing with Lightning."

Charles Ramey Jones (A'16, M'30) eastern transportation manager, Westinghouse Electric and Manufacturing Company, New York, N. Y., has been nominated to serve as vice-president of the AIEE New York City District (3). He was born May 11, 1886, at Norristown, Pa., and was graduated from the University of Pennsylvania with the degree of bachelor of science in electrical engineering in 1907. He joined the engineering apprentice course, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., in that year and since then has been continuously with the company. From 1909 to 1911 he was in the engineering and railway departments and in 1911 was transferred to the New York office as assistant to the manager, railway division. In 1916 he became sales engineer, representing the company on contracts involving electrification of steam railroads and power supply, and in 1925 was made section manager, transportation division. In 1930 he became eastern transportation manager. He was a director of the Institute 1935–39 and has been active in the affairs of the New York City District. He was secretary of the New York Section, 1930–31, and chairman, 1933–34. He has served on the committees on production and application of light, transportation, planning and coordination, and finance (chairman 1937–39), and the Lamme Medal, headquarters, and executive committees, in addition to special committees. He is at present serving on the Edison Medal committee and a special committee on pension plans.



E. T. Mahood

A. G. Dewars

E. W. Schilling

Edwin Terrell Mahood (A'26, M'28, F'36) engineer, Southwestern Bell Telephone Company, Kansas City, Mo., has been nominated for vice-president of the AIEE South West District (7). He was born August 3, 1887, St. Louis, Mo., and in 1904 was employed by the Bell Telephone Company there as a draftsman. He has been continuously employed in telephone plant and engineering work by this company and its successors since that time. He was made district plant engineer in Wichita, Kans., in 1911, division plant engineer, Little Rock, Ark., in 1912, and plant engineer, Topeka, Kans., in 1917. He was transferred to St. Louis as valuation engineer in 1919 and in 1926 became engineer in charge of the Western Missouri and Kansas area, Southwestern Bell Telephone Company. He is past chairman of the Kansas City Section and has been a member of the Sections committee since 1936.

Eugene W. Schilling (A'29, M'33) professor and head of the department of electrical engineering, Montana State College, Bozeman, has been nominated for vice-president of the AIEE North West District (9). He was born December 23, 1897, at Whatcheer, Iowa, and attended the University of South Dakota and the University of Illinois, receiving the degree of bachelor of science in electrical engineering from the latter in 1919. From Iowa State College he received the degrees of master of science in electrical engineering in 1930, doctor of philosophy in 1933, and electrical engineer in 1936. He became instructor in electrical engineering at Iowa State College in 1920 and three years later founded the consulting engineering firm of E. W. Schilling and Company, Brandon, S. Dak., in 1928 he returned to Iowa State College as instructor in electrical engineering and in 1931 was appointed assistant professor of electrical engineering at Michigan College of Mining and Technology, Houghton, advancing to the position of associate professor there in 1935. He was appointed to his present position in 1938. He is at present serving as chairman of the Montana Section and counselor of the AIEE Student Branch at Montana State College. He is also a member of the Society for the Promotion of Engineering Education, and Eta Kappa Nu. He is the author of a textbook, "Illumination Engineering," and a number of technical articles.

Allen Guthrie Dewars (A'17, M'27) manager, system planning department, Northern States Power Company, Minneapolis, Minn., has been nominated for vice-president of the AIEE Great Lakes District (5). He was born August 22, 1892, Minneapolis, Minn., and received from the University of Minnesota the degrees of bachelor of science in 1913 and electrical engineer in 1914. In 1914 he entered the employ of the St. Paul Gas Light Company, St. Paul, Minn. as an engineering apprentice and became distribution engineer in the transmission and distribution department in 1916. After an interval of army service, he returned to the St. Paul Gas Light Company in 1919 as assistant superintendent of distribution and became superintendent in 1925. When the company was taken over by the Northern States Power Company in 1926, he was made superintendent of research, transferring in 1929 to the Northern States Power Company headquarters, Minneapolis, as system planning engineer. In 1936 he was appointed engineer-member of a special committee to supervise the reclassification of company accounts in compliance with instructions issued by the Federal Power Commission. In 1940 he was appointed to his

W. R. Smith

K. L. Hansen

W. B. Morton

present position. He served as secretary of the Minnesota Section in 1924 and chairman in 1925, and has been secretary of the Great Lakes District since 1925. During 1936–37 he was a member of a special Institute committee on dues of Associates and related matters. He is also a member of the Edison Electric Institute.

Smith, Hansen, and Morton Nominated for Directorships

William Ralph Smith (M'18, F'30) safety engineer, electric department, Public Service Electric and Gas Company, Newark, N. J., has been nominated to serve as an AIEE director. He was born February 23, 1885, Charleston, S. C., and was graduated from Clemson College in 1906 with the degree of bachelor of science in mechanical and electrical engineering. During 1906–07 he was engineering assistant to the head of the engineering department, Clemson College, Clemson, S. C., and during 1907–08 he was an engineering apprentice with the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. In 1908 he joined the Hartford Suspension Company, Jersey City, N. J., as draftsman. From 1909 to 1911 he was manager of the New England branch of that company, Boston, Mass.; during 1911–12, manager of the Newark branch, Newark, N. J., and during 1912–13, engineer in charge of the department of design of automobile suspension fittings. He joined the Public Service Electric Company, Newark, N. J., in 1914 as an electrician in the construction department, in 1916 became division foreman, and in 1917 field engineer in charge of all electrical construction work. When the Public Service Production Company was formed in 1922, he became superintendent of the electrical construction department and in 1924 was appointed managing electrical engineer. In 1928 he was made assistant chief engineer, United Engineers and Constructors, Inc., Newark, N. J., and transmission construction engineer, Public Service Electric and Gas Company, having been appointed safety engineer in 1938. He has been a member of the AIEE board of examiners (chairman 1934–36), and has served also on the technical program committee and the committee on award of Institute prizes (chairman of both 1935–36), and on the publication and co-ordination of Institute activities committees, and is serving at present on the safety committee.

Klaus Lobeck Hansen (A'17, F'34) consulting electrical engineer, Harnischfeger Corporation, Milwaukee, Wis., has been nominated to serve on the AIEE board of directors. He was born September 14, 1882, Sandefjord, Norway, and came to the United States in 1901. He was employed by the National Stamping Works, and the Western Electric Company, both in Chicago, Ill., before entering the University of Illinois where he studied electrical engineering 1903–05. After several months with the Chicago Edison Company, he joined the Westinghouse Electric and Manufacturing Company, East Pittsburgh Pa., in 1906, working as draftsman and dynamo tester until 1913, when he became designing engineer on d-c apparatus. In 1919 he was employed by the Mechanical Appliance Company (later the Louis Allis Company), Milwaukee, as designing engineer, later becoming chief engineer. He left the company in 1921 to engage in consulting and development work on his own patents. He invented the Hansen arc welder, and in its manufacture and sale was associated with the Northwestern Manufacturing Company, Milwaukee, from 1924 to 1932. When that company was taken over by the Harnischfeger Corporation, he was retained in a consulting capacity. He holds patents on various arc-welding processes and joint patents on induction motors, and has published a number of technical papers chiefly relating to welding. He has been a member of the AIEE committee on electric welding (chairman 1932–34), and of the technical program committee; chairman of the Milwaukee Section, 1933–34; and chairman of the 1937 AIEE summer convention committee. He has been a vice-president of the Institute since 1940. He is also a member of the American Welding Society (past vice-president).

Walter Benson Morton (A'25, M'28) senior field engineer, Philadelphia Electric Company, Philadelphia, Pa., has been nominated for re-election as a director of the Institute. He was born in Dallas, Tex., February 3, 1896. From 1915 to 1919 he was electrician and chief electrician in the United States Navy, and from 1919 to 1923 was electrician and foreman at the Mare Island, Calif., Navy Yard. In 1923 he became a designer for the Pacific Gas and Electric Company, San Francisco, Calif., and was appointed construction foreman in 1924. In 1925 he joined the Alabama Power Company, Birmingham, Ala., as electrical designer, and in 1926 was placed in charge of the electrical design division of the engineering department. In 1931 he joined the Philadelphia Electric Company as project engineer, becoming senior project engineer in 1932, and senior field engineer in 1940. He is at present serving as a director of the Institute, and chairman of the Philadelphia Section. He was secretary of the Philadelphia Section 1938–41. He is also currently serving as a member of the Sections, membership, technical program, and transfers committees.

W. I. Slichter Renominated for Institute Treasurer

Walter Irvine Slichter (A'00, M'03, F'12) retired professor and head of the department of electrical engineering, Columbia University, New York, N. Y., has been renominated to serve as treasurer of the AIEE, a position he has held since 1930. He was an Institute manager, 1918–22; vice-president, 1922–24; and has served on many standing and special committees. He is at present a member of the Edison Medal, constitution and bylaws, and standards committees and represents the Institute on the boards of the Engineering Societies Library and the Engineering Foundation, the advisory board of the National Bureau of Engineering Registration, and the Engineering Societies Monographs committee. He is also a member of The American Society of Mechanical Engineers and the Society for the Promotion of Engineering Education, and is the author of a number of articles on technical subjects. A biographical sketch of Professor Slichter appeared in the July 1941 issue, page 353.

F. E. Ricketts Awarded Lamme Medal for 1941

Forrest Eugene Ricketts (A'16) vice-president, Consolidated Gas Electric Light and Power Company, Baltimore, Md., has been awarded the Lamme Medal for 1941 "for his contribution to the high reliability of power-supply systems, especially in the design of apparatus for selective relaying and circuit reclosure." He was born February 18, 1878, Montgomery County, Md., and attended George Washington University and Bliss Electrical School. After employment with the Los Angeles, (Calif.), Pacific Railway Company, and the Philadelphia (Pa.) Mining Company,

F. E. Ricketts

he joined the Potomac Electric Power Company, Washington, D. C. In 1905 he was employed by the Consolidated Gas Electric Light and Power Company as an electrician and has been with the company since then, serving successively as chief operator, superintendent of electric stations, and director of intersystem power-utilization bureau, and becoming vice-president in 1938. He has worked on the development of electrical testing methods, and safety and control equipment, and has invented devices relating to electric-arc extinguishers, automatic electric regulators, and relay systems. He has served on the AIEE committees on protective devices and transmission and distribution. He was presented a Modern Pioneer award in 1940 by the National Association of Manufacturers.

T. H. Morgan (A'23, F'39) professor of electrical engineering and head of the department, Worcester Polytechnic Institute, Worcester, Mass., has been appointed principal specialist in engineering education in the United States Office of Education, Washington, D. C. He was born September 23, 1892, Fredericton, New Brunswick, and received from Stanford University the degrees of bachelor of arts in 1920 and bachelor of engineering in 1929. He was testing engineer, Inspiration Consolidated Copper Company, Inspiration, Ariz., 1920–21, and engineer, Great Western Power Company, San Francisco, Calif., 1921–22. He became instructor in electrical engineering, Stanford University, in 1922 and was made assistant professor and assistant to the executive head of the electrical engineering department of that institution in 1927. In 1931 he went to Worcester Polytechnic Institute as professor of electrical engineering and head of the department. He has been AIEE representative on the council of the American Association for the Advancement of Science, has been a member of the AIEE committee on education and is currently serving on the committee on electrical machinery. He is also a member of Sigma Xi and Tau Beta Pi, and is the author of a number of technical papers. **F. J. Adams** (A'04, M'13) professor of electrical engineering Worcester Polytechnic Institute, has been named acting head of the department of electrical engineering. He received from Worcester Polytechnic Institute the degrees of bachelor of science in 1904 and electrical engineer in 1906. During 1906–07 he was associated with the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. From 1907 to 1913 he was an instructor at Worcester Polytechnic Institute. He was assistant to the superintendent of distribution, Worcester Electric Light Company, 1913–15 and in 1915 returned to Worcester Polytechnic Institute as instructor, in 1917 being made assistant professor of electrical engineering. He was assistant engineer, New England Power Construction Company, during 1929–30 and in 1930 became professor of electrical engineering at Worcester Polytechnic Institute. He is also a member of the Society for the Promotion of Engineering Education.

H. F. McRell (A'25) sales manager, distribution transformers section, General Electric Company, Pittsfield, Mass., has been appointed assistant manager of the transformer division of the company's central-station department. He has been associated with the General Electric Company since 1910 when he entered the test course. In 1913 he joined the sales department of the transformer division, in 1924 became sales manager. **H. M. Jalonack** (M'36) assistant sales manager, distribution transformers and feeder voltage regulators, has been appointed sales manager. In 1917 he entered the General Electric test course, and in 1923 became district transformer specialist. **R. W. Adams** (A'06, M'12) district manager, central-station department, Boston, Mass., has been named assistant district manager, New England District. After being employed in the testing department of B. F. Sturtevant Company 1904–05 and as electrical engineer, D. and W. Fuse Company, Providence, R. I., 1905–08, he joined the General Electric Company, Pittsfield, Mass., as design engineer in 1908. He was manager of the Providence office 1913–28 and became district manager of the central-station department, Boston, in 1928. **R. W. Herrick** (A'28) manager of the General Electric Providence office since 1928, has been appointed manager, central-station department, New England District. He has been associated with the General Electric Company since 1905, starting in the Boston office and transferring to Providence as salesman in 1918. **D. E. Walch** (M'31) salesman, Boston office, has been appointed manager of the Providence office. He has been with General Electric as a salesman since 1923, working successively as motor specialist, power-factor specialist, and sales engineer. **W. R. G. Baker** (A'19, M'41) vice-president in charge of radio and television, Bridgeport, Conn., has been presented a gold escutcheon plaque by the Institute of Radio Engineers in recognition of his work as chairman of the national television systems committee. **T. F. Barton** (A'12, F'30) district manager, New York, N. Y., has been elected vice-president of the Engineers' Club, New York, N. Y. He is currently a director of the Institute.

F. R. Phillips (M'27) former president Philadelphia Company and subsidiary companies, Pittsburgh, Pa., has been elected chairman of the board and chairman of the executive committee following his resignation as president of the company. He was born October 29, 1876, Cleveland, Ohio, and studied engineering by private tutor and at the Case School of Applied Science. In 1894 he joined the engineering department of the Cleveland City Railway Company, and in 1903 when the company was consolidated with the Cleveland Electric Company, he was appointed assistant master mechanic. In 1904 he became master mechanic for the Cincinnati, Newport, and Covington Light and Traction Company. In 1907, he was design engineer, Ohio Brass Company, and in 1908 he joined the United Light and Traction Company as chief engineer. He became superintendent of equipment, Pittsburgh Railways Company, in 1910, acting general manager in 1923, and mechanical and electrical engineer in 1924. He was appointed vice-president and general manager of the Duquesne Light Company in 1926 and retaining this office, became vice-president of the Equitable Gas Company in 1928. He was made senior vice-president of the Philadelphia Company in 1929, president of the Philadelphia Company subsidiaries also in that year, and in 1931, became president of the Philadelphia Company as well.

Ernst Weber (A'31, F'34) research professor of electrical engineering, Polytechnic Institute of Brooklyn, Brooklyn, N. Y., has been appointed head of the new department of graduate study and research in electrical engineering of that institution with the title of professor of graduate electrical engineering. He was born September 6, 1901, Vienna, Austria, and received the degrees of electrical engineer in 1924, and doctor of technical sciences in 1927 from the Technical University of Vienna, and doctor of philosophy from the University of Vienna in 1926. He was employed as research engineer by the Oesterreichische Siemens-Schuckert, Vienna, in the department for the design of electrical machines from 1924 to 1929 when he took a similar position with the Siemens-Schuckert Company, Berlin, Germany. During 1929–30 he held a professorship in the department of electrical engineering at the Technical University, Charlottenburg, Berlin. He was visiting professor, Polytechnic Institute of Brooklyn, 1930–31, and in 1931 was appointed research professor. He is also a member of Tau Beta Pi, Eta Kappa Nu, American Association for the Advancement of Science, the Society for the Promotion of Engineering Education, and the American Physical Society, and is the author of a number of technical papers.

Maurice Holland (A'23, M'30) director, division of engineering and industrial research, National Research Council, New

York, N. Y., has been appointed industrial research adviser, New York University, College of Engineering, New York, N. Y. He was graduated from Massachusetts Institute of Technology in 1916. He was general engineering assistant on the construction of the Grand Trunk Railroad through Rhode Island, 1912–13, and assistant to the chief engineer, Boston (Mass.) Transit Commission, 1913–14. During 1914–17, he was assistant to the chief, installations division, Edison Electric Illuminating Company, Boston, Mass. He was a lieutenant-pilot, United States Air Service, 1917–18, and was with the engineering division, United States Air Service, 1918–20. In 1921 he was put in charge of the organization and supervision of the industrial engineering branch, engineering division, United States Air Service. Since 1923 he has been director of the division of engineering and industrial research, National Research Council. He is also a member of the American Association for the Advancement of Science, and the New York Academy of Science.

A. W. Pride (A'20) sales manager, Westinghouse Electric and Manufacturing Company, Emeryville, Calif., has been appointed commercial transformer engineer. From 1915 to 1917 he was an apprentice in the research engineering division, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. From 1918 to 1919 he was with the Magnetic Laboratory Bureau of Standards, Washington, D. C., and the Naval Experiment Station, New London, Conn., and was employed later as engineer with the Electric Auto-Lite Corp., Toledo, Ohio. He rejoined the Westinghouse Electric Company in 1922 in the porcelain department, Derry, Pa., and the following year was transferred to the company's Pacific Coast Division, where he has served in sales and engineering capacities in both the transformer division and the porcelain department.

R. B. Shepard (A'25, F'36) senior resident engineer and head of electrical work, Underwriters' Laboratories, Inc., New York, N. Y., has been appointed chief electrical engineer in charge of all electrical department work in the New York, Chicago, and San Francisco testing stations. He was born November 13, 1888, Hudson, N. Y., and was graduated from Union College, Schenectady, N. Y., in 1910 with the degree of bachelor of engineering. In that year he joined the switchboard department, General Electric Company, Schenectady, N. Y., and in 1912 entered the Underwriters' Association of New York State, Schenectady, N. Y., as an inspector. In 1913 he was transferred to the company's New York office. He has been chief electrical engineer since 1924.

C. W. Mayott (A'13) manager, Connecticut Valley Power Exchange, Hartford, Conn., and a member of the technical staff of the Hartford Electric Light Company, has been appointed by the Office of Production Management to serve as administrator of the interconnected power system resulting from the pooling of 40 publicly and privately owned utility companies in 13 southeastern states. He received the degree of electrical engineer from Rensselaer Polytechnic Institute in 1911 and joined the Hartford Electric Light Company in that year, becoming assistant superintendent in 1912 and mechanical engineer in 1921. He remained with the company until 1925 when he became manager of the Connecticut Valley Power Exchange.

G. C. Hall (A'07, M'18) electrical engineer, motive power department, Interborough Rapid Transit Division, New York City Transit System, N. Y., has recently retired. He was employed by the Metropolitan West Side Elevated Railway Company, Chicago, Ill., 1896–99, by Stone and Webster Engineering Corporation, Boston, Mass., 1899–1900, and by the Manhattan Elevated Railway Company, New York, N. Y., 1900–04. He was with the Interborough Rapid Transit Company, New York, N. Y., from 1904 and retained his position when the company became a part of the New York City Transit System in 1940.

H. H. Hunter (A'37) former senior electrical engineer for the West Virginia Public Service Commission, Charleston, W. Va., has been appointed senior assistant utilities engineer for the Maryland Public Service Commission. After graduating from the University of West Virginia in 1928 with the degree of bachelor of science in electrical engineering, he entered the test department of the General Electric Company and in 1929 joined the industrial control engineering department. In 1934 he joined the Public Service Commission of West Virginia.

A. S. Kirk (A'21) industrial service engineer, Blackstone Valley Gas and Electric Company, Woonsocket, R. I., has been appointed assistant chief industrial service engineer. He joined Stone and Webster, Boston, Mass., in 1920 as electrical draftsman and designer, and in 1925 he was employed by the Blackstone Valley Gas and Electric Company. Two years later he was made industrial service engineer.

H. Y. Hall (A'03, F'37) superintendent, Waterside Station, Consolidated Edison Company of New York, Inc., New York, N. Y., has been appointed production superintendent. **H. A. Bauman** (A'26, M'41) assistant superintendent, production department, Brooklyn Edison Company, Brooklyn, N. Y., has been made electrical superintendent.

A. L. Davis (A'17, M'31) assistant superintendent, Western Massachusetts Companies, Greenfield, Mass., has been elected vice-president of the Electric Lines Club, a New England central-station specialist group of engineers and operating men.

G. Ross Henninger (A'22, M'27) AIEE editor, New York, N. Y., has been elected president of the Haworth, N. J., board of education. He has also been re-elected a member of the board of trustees of the Haworth Public Library.

H. L. Rorden (A'30, M'36) former development engineer, Barberton Division, Ohio Brass Company, Barberton, Ohio, is now engaged in work on high-voltage problems at the Bonneville Dam, Portland, Ore.

J. W. Sheffer (A'10, M'13) electrical engineer, American Car and Foundry Company, New York, N. Y., has been appointed general electrical engineer. He has been with the company since 1908.

OBITUARY • • • •

Bion Joseph Arnold (A'92, M'93, F'12) consulting engineer and president, Arnold Engineering Company, Chicago, Ill., died January 30, 1942. He was born August 14, 1861, Casnovia, Mich., and received the degrees of bachelor of science, 1884, master of science, 1887, and honorary doctor of philosophy, 1889, from Hillsdale College. He did graduate work in electrical engineering at Cornell University, received from the University of Nebraska the degrees of electrical engineer in 1897 and doctor of engineering in 1911, and was awarded the honorary degree of doctor of science from Armour Institute of Technology, Chicago, Ill., 1907. From 1887–89 he was chief draftsman and mechanical engineer, Chicago Great Western Railway, and engineer and manager, St. Louis office, 1889–92. He was consulting engineer, Thomson-Houston Electric Company, Chicago, Ill., 1892–93, during which time he was engaged in the design and construction of the Columbian Intramural Railway, World's Columbian Exposition, Chicago, Ill., one of the first electric elevated railways in the United States. He had been an independent consulting engineer since 1893. He did construction work for the Chicago-Milwaukee Electric Railway, and the Lansing, St. Johns, and St. Louis Railway, and played an important part in the electrification of the Grand Trunk Railroad. He was also associated with the electrification of the Grand Central Terminal, New York, N. Y., and the development of the New York subway system. He was consulting engineer on surface and underground traction problems for cities throughout the United States. During World War I he made a survey of aircraft supply and production facilities for the United States Army and Navy and had charge of the development and production of aerial torpedos. He served as a manager of the Institute 1895–98, vice-president 1902–03, and president 1903–04. He was one of the pioneers in the develop-

ment of single-phase electric traction system, and the standard a-c and d-c system, and was the author of a number of technical articles. In 1929 he received the Washington Award. He was also a member of the American Society of Civil Engineers and the Society for the Promotion of Engineering Education.

William Sleeper Aldrich (A'92, M'00) retired engineering consultant, died December 22, 1941. He was born March 3, 1863, Philadelphia, Pa., was graduated from the United States Naval Academy, Annapolis, Md., in 1883, and received the degree of mechanical engineer from Stevens Institute of Technology, Hoboken, N. J., 1884. He taught at the Boys' High School, Reading, Pa., 1885–87, and at Central Manual Training School, Philadelphia, Pa. 1887–89, before becoming instructor in drawing, department of electrical engineering, and associate in mechanical engineering, Johns Hopkins University, in 1889. In 1893 he became professor of mechanical engineering, West Virginia University, where he also gave courses in electrical engineering. In 1899 he went to the University of Illinois as head of the department of electrical engineering and from 1901 to 1910 he was director, Clarkson College of Technology, Potsdam, N. Y. After a year at the University of Arizona as acting professor of mechanical and electrical engineering, he joined the electrical engineering department of Colorado State Agricultural College. In 1918 he became associated with the American Bridge Company, Gary, Ind., and retired in 1931. Since 1896 he had also been engaged in work as an engineering consultant. He was also a member of the American Society of Mechanical Engineers, the Franklin Institute, the Society of the Promotion of Engineering Education, and the American Association for the advancement of Science.

Boris E. Kovediaeff (A'28) assistant engineer, bridge section, United States Engineers, Los Angeles, Calif., died in April 1941. He was born March 29, 1884, in Russia and was a graduate of the Imperial University of Kharkof, and of the Polytechnic Institute of the Emperor Peter I, having received the degree of electrical engineer from the latter in 1915. During 1912–14 he was employed in the government office for the irrigation of Chou Valley, Turkestan, and in 1915 became superintendent of war supply manufacturing, P. V. Baranovsky Corporation, Petrograd, Russia. During 1918–19 he was employed in designing distribution lines at Vladivostock, Siberia, for the Russian government, and came to the United States in 1920 when he became electrician at the Union Iron Works, Bethlehem Shipbuilding Corporation, San Francisco, Calif. From 1921 to 1925 he owned the Guarantee Electric Company, Los Angeles, Calif., and was engaged in contracting and consulting electrical work. He was assistant engineer, Metropolitan Water District of Southern California, Los Angeles, from 1934 to 1936 when he became assistant engineer with the United States Engineers.

Otto Schalcher (A'39) librarian, City of New York, Staff House, City Home, Welfare Island, died November 3, 1941. He was born August 26, 1895, Burgdorf, Switzerland, and was graduated from the State College, Burgdorf, with the degrees of mechanical engineer in 1914 and electrical engineer in 1915. He was employed by Brown Boveri and Company, Ltd., Baden, Switzerland, for about eight years in various engineering capacities, joining the American Brown, Boveri Electric Corporation, Camden, N. J., in 1927, as electrical engineer. In 1929 he became design engineer, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., and after a short time as draftsman with Lockwood, Green, Engineers, Inc., he was engaged in 1934 to give treatments with a high-frequency ultraviolet lamp to patients at the City Home, Welfare Island, where he later became librarian.

William Maxwell Scott (A'97) president, I-T-E Circuit Breaker Company, Philadelphia, Pa., died January 19, 1942. He was born in North Wales, Pa., in 1873, and was graduated from Towne Scientific School as a mechanical engineer in 1892. Two years later he was employed by the Cutter Electrical and Manufacturing Company, Philadelphia, Pa., where he advanced to the position of chief engineer. In 1900 he was appointed to do management work with the Cutter Electrical Company, and became treasurer and general manager in 1912 and vice-president in 1922, retaining his position as treasurer. In 1928 the company was reorganized as the I-T-E Circuit Breaker Company and the following year he became president. He was also a member of the Franklin Institute.

Paul W. Koch (A'28) president, Paul W. Koch Company, Chicago, Ill., died September 2, 1941. He was born November 15, 1886, Peoria, Ill., and attended the University of Illinois. From 1907 to 1910 he held various positions with the City Railway Company, Chicago, Ill., including assistant to the division engineer of substations. In 1911 he became electrical salesman, Wagner Electric Company, and the following year, manager, Thomas G. Grier Company. In 1915 he became president, Paul Koch Company, distributor of scientific and technical equipment. He was a Chicago representative of the Condit Electrical Manufacturing Company (now Allis-Chalmers Boston Works), Boston, Mass., for 30 years.

Roy H. Petterson (A'37) Lieutenant, United States Navy, office of inspector of naval material, Schenectady, N. Y., died January 8, 1942. He was born May 26, 1908, Brooklyn, N. Y., and was graduated from Brooklyn Polytechnic Institute, Brooklyn, N. Y. From 1928 to 1934 he was engineering assistant, Brooklyn Edison Company, Brooklyn, N. Y. when he became junior engineer, commercial engineering bureau, Brooklyn Edison Company. He later became sales technical representative, Consolidated Edison Company of New York (N. Y.), and in 1941 joined the office of the inspector of naval material. He was also a member of Eta Kappa Nu.

John Laws Belden (A'36) transportation department, General Electric Company, New York, N. Y., died October 5, 1941. He was born September 29, 1907, Oakland, Calif., and was graduated from the University of California with the degrees of bachelor of science and mechanical engineer. He entered the test course, General Electric Company, Schenectady, N. Y., in 1929 and the following year became supervising field engineer for the company installing substations for the Delaware, Lackawanna and Western Railroad, New York Central Railroad, and New York Board of Transportation. He was later made commercial engineer.

John Harris Patterson (A'39) apprentice meter engineer, Ohio Power Company, Canton, Ohio, died July 19, 1941 as the result of an automobile accident. He was born February 4, 1913, Fort Benton, Mont., and was graduated from the University of Cincinnati with the degree of electrical engineer in 1938. During 1936 he was draftsman and shop worker, B. A. Wesche Electric Company, Cincinnati, Ohio. After a short time with the Cincinnati Gas and Electric Company, he joined the Ohio Power Company as apprentice meter engineer in 1939.

S. McDougall (A'34) district plant superintendent, long lines department, American Telephone and Telegraph Company, Denver, Colo., died December 23, 1941. He was born May 11, 1878, Osage City, Kansas. He was a railroad telegrapher and train dispatcher, Kansas City Suburban Belt Railroad, from 1896 to 1906, when he entered the American Telephone and Telegraph Company as wire chief. In 1908 he was appointed chief testboard man, Kansas City, Mo., and in 1913 became district plant superintendent, Kansas City, Mo., and Denver, Colo.

William Thomas Croden (A'37) power dispatcher, Metropolitan Water District of Southern California, Eart, died on January 12, 1942, after an automobile accident. He was born April 22, 1898, in Los Angeles, Calif. During 1916–17 he did electrical maintenance work with the Pacific Portland Cement Company, San Francisco, Calif., and from 1917–25 he was employed by the Southern California Edison Company as electrical maintenance worker and power substation operator. In 1933 he joined the Metropolitan Water District of Southern California as chief operator.

Donald William Cooper (A'40) second lieutenant, ordnance department, United States Army, Elmendorf Field, Alaska, died September 29, 1941.

MEMBERSHIP • •

Recommended for Transfer

The board of examiners, at its meeting on February 19, 1942, recommended the following members for transfer to the grade of membership indicated. Any objection to these transfers should be filed at once with the national secretary.

To Grade of Fellow

Allen, A. E., Southwest District engineer, General Electric Company, Dallas, Tex.
Brunn, G. T., electrical engineer, Kopper's Co., Pittsburgh, Pa.
Moore, L. J., division executive engineer, Pacific Gas and Electric Company, Fresno, Calif.

3 to grade of Fellow

To Grade of Member

Beetem, F. G., manager, electrical division, The Electric Storage Battery Company, Philadelphia, Pa.
Booth, R. D., partner, Jackson and Moreland, Boston, Mass.
Boyer, O. A., testing and regulating chief, Western Union Telegraph Company, Houston, Tex.
Brown, H. H., Electrical Engineer, Iowa Electric Light and Power Company, Cedar Rapids, Iowa.
Donatic, E. F., general foreman, Republic Steel Corporation, Chicago, Ill.
Dunlap, G. W., development engineer, General Electric Company, Schenectady, N. Y.
Fenwick, J. O., transformer engineer, Line Material Company, Zanesville, Ohio.
Graff, J. M., assistant to electrical engineer, Consolidated Gas Electric Light and Power Company, Baltimore, Md.
Kenyon, A. F., industry engineer, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Lawther, H. P., general transmission and protection engineer, Southwestern Bell Telephone Company, St. Louis, Mo.
Lindsay, R. H., radio engineer, Bell Telephone Laboratories, Inc., New York, N. Y.
Myers, C. F., assistant engineer, Puget Sound Power and Light Company, Seattle, Wash.
Pretty, H. R., electrical engineer, Oklahoma Gas and Electric Company, Oklahoma City, Okla.
Steinhauer, W. H., assistant to vice-president, Toledo Edison Company, Toledo, Ohio.
Stenger, L. A., engineer, Great Western Sugar Company, Denver, Colo.
Yetter, P. A., district superintendent, Public Service Company of Colorado, Fort Collins, Colo.

16 to grade of Member

Applications for Election

Applications have been received at headquarters from the following candidates for election to membership in the Institute. Names of applicants in the United States and Canada are arranged by geographical District. If the applicant has applied for direct admission to a grade higher than Associate, the grade follows immediately after the name. Any member objecting to the election of any of these candidates should so inform the national secretary before March 31, 1942, or June 30, 1942 if the applicant resides outside of the United States or Canada.

United States and Canada

1. North Eastern

Beckwith, R. W., General Electric Company, Schenectady, N. Y.
Berger, R. C., General Electric Company, Schenectady, N. Y.
Blackburn, J. A., General Electric Company, Schenectady, N. Y.
Brady, G. F., General Electric Company, Pittsfield, Mass.
Brelsford, H. H., General Electric Company, Schenectady, N. Y.
Brown, C. R., Coast Artillery Corps, Boston, Mass.
Bush, M. M., General Electric Company, Pittsfield, Mass.
Carlson, G. W., Stromberg-Carlson Telephone Manufacturing Company, Rochester, N. Y.
Carlson, W. A., 101 Williams Street, Malden, Mass.
Carson, V. S., University of Connecticut, Storrs, Conn.
Chaffee, R. E., 68 Prospect Street, Belmont, Mass.
Chambers, R. M., Jr., Taunton, Mass.
Chapman, C. R., General Electric Company, Schenectady, N. Y.
Chodakowski, A. S., General Electric Company, Lynn, Mass.
Connor, H. F., Jr., General Electric Company, Lynn, Mass.
Croxford, F. W., General Electric Company, Boston, Mass.
Cushman, G. S., United States Naval Reserve, Fall River, Mass.
Davenport, W. B., Jr., Massachusetts Institute of Technology, Cambridge, Mass.
Dehn, R. A., General Electric Company, Schenectady, N. Y.
Dobbins, W. E., 1246 Prendergast Avenue, Jamestown, N. Y.
Eiland, B. H., Jr., United States Army, Pine Camp, N Y.
Eisengrein, R. H., General Electric Company, Schenectady, N. Y.
Eldridge, E. H., General Electric Company, Schenectady, N. Y.
Engelkamp, J. C., General Electric Company, Schenectady, N. Y.
Evans, T. N., Jr., General Electric Company, Lynn, Mass.
Faytinger, R. D., General Electric Company, Schenectady, N. Y.
Fowler, G. A., Massachusetts Institute of Technology, Cambridge, Mass.
Fraser, W. R., General Electric Company, Pittsfield, Mass.
Friberg, V. P., General Electric Company, Schenectady, N. Y.
Fritz, R. M., United States Navy, U.S.S. Denebola, % Postmaster, Portland, Maine.
Gasparoli, R. E., General Electric Company, Schenectady, N. Y.
Geder, G. S., General Electric Company, Schenectady, N. Y.
Gilbert, A. C., Jr., General Electric Company, Schenectady, N. Y.
Gogolick, R. M., Massachusetts Institute of Technology, Cambridge, Mass.
Hansen, E. F., General Electric Company, Lynn, Mass.
Hardgrave, W. F., General Electric Company, Schenectady, N. Y.
Hollingsworth, G. L., General Electric Company, Schenectady, N. Y.
Houser, P. H., General Electric Company, Schenectady, N. Y.
Jones, L. M., General Electric Company, Lynn, Mass.
Judd, O. C., General Electric Company, Schenectady, N. Y.
Keppel, W. H., General Electric Company, Schenectady, N. Y.
Hartley, J. C., General Electric Company, Schenectady, N. Y.
Holley, C. H., General Electric Company, Lynn, Mass.
Hutchins, W. C. (Member), General Electric Company, Schenectady, N. Y.
Jackson, F. D. (Member), University of New Hampshire, Durham, N. H.
Kelling, L. U. C., General Electric Company, Schenectady, N. Y.
Langenkamp, Q. W., General Electric Company, Schenectady, N. Y.
Lawrence, M. J., Harvard University, Cambridge, Mass.
Leighton, J., Southern New England Telephone Company, New Haven, Conn.
Lentros, G. P., Lombard Governor Corporation, Ashland, Mass.
Levy, M. L., General Electric Company, Schenectady, N. Y.
Lindquist, E. H., General Electric Company, Schenectady, N. Y.
Linowiecki, A. G., General Electric Company, Schenectady, N. Y.
Marcy, H. T., Massachusetts Institute of Technology, Cambridge, Mass.
Meier, E. H., General Electric Company, Schenectady, N. Y.
Miller, D. R., General Electric Company, Schenectady, N. Y.
Murdock, G. W., Greenwood, N. Y.
Myers, D. C., General Electric Company, Lynn, Mass.
Nugent, A. G., Bethlehem Steel Corporation, Lackawanna, N. Y.
Oliver, N. J., National Defense Research Committee, Massachusetts Institute of Technology, Cambridge, Mass.
Ornitz, D. E., General Electric Company, Lynn, Mass.
Pagani, N. D., General Electric Company, Schenectady, N. Y.
Peterson, F. W., General Electric Company, Schenectady, N. Y.
Phillips, V. E., General Electric Company, Schenectady, N. Y.
Pierce, R. H., New England Power Service Company, Providence, R. I.
Pilotti, E. F., Southern New England Telephone Company, Bridgeport, Conn.
Potter, S. M., United Aircraft Corporation, East Hartford, Conn.
Reeser, E. S., Jr., General Electric Company, Schenectady, N. Y.
Roberts, F. M. (Member), General Electric Company, Schenectady, N. Y.
Rockwell, O. M., General Electric Company, Pittsfield, Mass.
Romanach, T. M., General Electric Company, Schenectady, N. Y.
Rosaler, R. C., United States Navy Yard, Boston, Mass.
Ruyle, H. C., Jr., General Electric Company, Pittsfield, Mass.
Samsel, R. W., General Electric Company, Schenectady, N. Y.
Schaeffer, G. H., Jr., General Electric Company, Schenectady, N. Y.
Sherman, L. S., General Electric Company, Schenectady, N. Y.
Sielicki, A. J., Allis-Chalmers Manufacturing Company, Boston, Mass.
Slind, M. T., General Electric Company, Bridgeport, Conn.
Stocking, H. E., General Electric Company, Schenectady, N. Y.
Strandberg, M. W. P., Massachusetts Institute of Technology, Cambridge, Mass.
Sweeney, J. H., Jr., General Electric Company, Schenectady, N. Y.
Taylor, E. L., Public Utilities Commission of Connecticut, New Haven, Conn.
Thulin, C. W., Worcester Polytechnic Institute, Worcester, Mass.
Tiezzi, A. A., General Electric Company, Pittsfield, Mass.
Tuthill, R. W., General Electric Company, Schenectady, N. Y.
Vermeulen, W., General Electric Company, Schenectady, N. Y.
Wagner, R. A., Division of National Defense Research, Columbia University, New London, Conn.
Warner, J. L., General Electric Company, Schenectady, N. Y.
Washburn, R. B., General Electric Company, Lynn, Mass.
Weary, J. F., General Electric Company, Schenectady, N. Y.
Webster, J. D., Jr., General Electric Company, Schenectady, N. Y.
Willard, G. D., 229 North Union Street, Olean, N. Y.
Wright, W. G., Harvard University, Boston, Mass.
Zecher, R. O., General Electric Company, Schenectady, N. Y.
Zweig, F., Yale University, New Haven, Conn.

2. Middle Eastern

Adams, C. T., Henry Adams, Incorporated, Baltimore, Md.
Allan, W. G. (Member re-election), Philadelphia Museum of Art, Philadelphia, Pa.
Anderson, C. E., Jr., General Electric Company, Philadelphia, Pa.
Antman, M. A., United States Army, Signal Corps, Camden, N. J.
Armington, R. E., Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Armstrong, W. H., Consolidated Gas, Electric Light and Power Company, Baltimore, Md.
Balavny, P. B., Navy Yard, Philadelphia, Pa.
Balwanz, W. W., United States Civil Service Commission, Washington, D. C.
Basnett, R. T., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Bechtel, C. B., Consolidated Gas, Electric Light and Power Company, Baltimore, Md.
Bell, R. H., Jr., Maryland Drydock Company, Fairfield, Baltimore, Md.
Benowitz, H. S., United States Army, Signal Corps, Philadelphia, Pa.
Bereskin, A. B., University of Cincinnati, Cincinnati, Ohio.
Bershad, L., United States Army, Signal Corps, Philadelphia, Pa.
Binkley, E. R., Pennsylvania Power and Light Company, Allentown, Pa.
Brubaker, V. W., American Viscose Corporation, Lewistown, Pa.
Bucher, T. T. N., RCA Manufacturing Company, Camden, N. J.
Buchta, M. A., General Electric Company, Philadelphia, Pa.
Carlson, K. J., Naval Ordnance Laboratory, Navy Yard, Washington, D. C.
Carter, D. F., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Penna.
Charp, S., University of Pennsylvania, Philadelphia, Pa.
Cheek, R. C., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Chizmadia, A. A., Philadelphia Electric Company, Philadelphia, Pa.
Costa, D. T., Sun Shipbuilding and Drydock Company, Chester, Pa.
Daly, T. A. (Associate re-election), Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Davidson, D. R., Cleveland Electric Illuminating Company, Cleveland, Ohio.
Davis, R. H., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
DeAntonis, V. J., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Dewey, C. G., General Electric Company, Philadelphia, Pa.
Duncan, C. S., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Emerson, W. J., Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Fehr, F. S., Metropolitan Edison Company, Reading Pa.
Ferguson, R. A., Allis-Chalmers Manufacturing Company, Pittsburgh, Pa.
Fortunato, J. J., Pennsylvania Electric Company, Indiana, Pa.
Freas, M. A., Navy Department, Baltimore, Md.
Fry, E. H., Bethlehem Steel Company, Bethlehem, Pa.
Fry, S., United States Navy, Washington, D. C.
Garrison, D. H., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Gerlach, F. H., Westinghouse Electric and Manufacturing Company, Lima, Ohio.

Glass, R. E., Westinghouse Electric and Manufacturing Company, Baltimore, Md.
Guy, J. R., Cleveland Electric Illuminating Company, Cleveland, Ohio.
Haggard, C. L., Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Hahn, V. H., Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Haiflich, N. J., Naval Ordnance Laboratory, Navy Yard, Washington, D. C.
Hall, L. J., United States Maritime Commission, Washington, D. C.
Henderson, J. R., Union Switch and Signal Company, Swissvale, Penna.
Herman, L. C., Hygrade Sylvania Corporation, Emporium, Pa.
Highsmith, J. L., Leeds and Northrup Company, Philadelphia, Pa.
Holland, R. C., Rural Electrification Administration, Washington, D. C.
Homan, R. A., United States Army, Edgewood Arsenal, Md.
Housel, F. H., Philadelphia Electric Company, Philadelphia, Pa.
Hunt, C. M., Rosenblatt and Hunt, Charleston, W. Va.
Hutchinson, R. W., Navy Yard, Philadelphia, Pa.
Ilgen, L., Duquesne Light Company, Pittsburgh, Pa.
Irick, J., Capital Transit Company, Washington, D. C.
Jaremko, P., Bureau of Ships, Navy Department, Washington, D. C.
Johnson, B. B., III, Charles Lennig and Company, Incorporated, Philadelphia, Pa.
Johnson, J. D., Bureau of Ordnance, Washington, D. C.
Johnston, W. E., Jr., Rural Electrification Administration, Washington, D. C.
Jones, C. H., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Kebernick, O. C., University of Pittsburgh, Pittsburgh, Pa.
Keen, G. W. (Member), Consolidated Gas, Electric Light and Power Company, Baltimore, Md.
Keller, W. T. (Member), The Austin Company, Euclid, Ohio.
Keroes, H. I., Navy Yard, Philadelphia, Pa.
Ketcham, A. R., Jr., Toledo Edison Company, Toledo, Ohio.
Kirst, C. E. R., Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Kleine, R., Cincinnati Gas and Electric Company, Cincinnati, Ohio.
Kowalyshyn, S., Jr., Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Kraitsik, I., Navy Department, Washington, D. C.
Kristofl, W. W., Jr., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Kuehn, R. E., General Electric Company, Philadelphia, Pa.
Lampson, S., General Electric Company, Philadelphia, Pa.
Lapuyade, H. P., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Larson, D. N., United States Naval Reserve, Bureau of Aeronautics, Washington, D. C.
Love, H. W., United States Army, Aberdeen Proving Ground, Md.
Love, W. E., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Lucic, A., Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Lyons, R. C., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Maccubbin, C. W., Consolidated Gas, Electric Light and Power Company, Baltimore, Md.
Mac Williams, W. H., Jr., Navy Department, Bureau of Ordnance, Washington, D. C.
Mandeen, E. E., Dravo Corporation, Pittsburgh, Penna.
Marquart, E. J., Jr., Ohio Public Service Company, Lorain, Ohio.
Mc Elwee, G. F., General Electric Company, Erie, Pa.
McKee, E. S., Naval Ordnance Laboratory, Erie, Pa.
Merriel, A. C., Sun Shipbuilding and Drydock Company, Chester, Pa.
Morris, A., United States Navy Yard, Philadelphia, Pa.
Moye, C. L., Pennsylvania Railroad Company, Philadelphia, Pa.
O'Neill, J. J., I-T-E Circuit Breaker Company, Philadelphia, Pa.
Palevsky, H. H., Naval Ordnance Laboratory, Washington, D. C.
Parker, F. T., General Electric Company, Philadelphia, Pa.
Parker, R. O., Koppers Company, Pittsburgh, Pa.
Peterson, J. P., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Plunkett, E. L., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Ponstingl, J. C., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Porter, V. J., Leeds and Northrup Company, Philadelphia, Pa.
Pouy, R. H., United States Army, Signal Corps., Philadelphia, Pa.
Powers, D. A., Public Utilities Commission, Columbus, Ohio.
Price, D. W., Chesapeake and Potomac Telephone Company of Baltimore City, Frederick, Md.
Pritchard, W. S. (Member), Ohio Bell Telephone Company, Cleveland, Ohio.
Quarles, F. W., Consolidated Gas, Electric Light and Power Company, Baltimore, Md.
Randall, M. E., Rural Electrification Administration, Washington, D. C
Reed, F. L., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Reiling, G. E., RCA Manufacturing Company, Camden, N. J.
Resch, J. P., Westinghouse Electric and Manufacturing Company, E Pittsburgh, Pa.
Rix, V. W., Rural Electrification Administration, Washington, D. C.
Ross, A. M., Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Samuelson, R. H., United States Navy, Anacostia, D. C.
Schlegel, T. A., Navy Department, Washington, D. C.
Schmid, H. B., Navy Department, Washington, D. C.
Schuman, A., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Scott, C. L., Westinghouse Electric and Manufacturing Company, Cleveland, Ohio.
Scott, N. R., United States Army, Signal Corps, Wright Field, Dayton, Ohio.
Shamis, R. J., Naval Ordnance Laboratory, Navy Yard, Washington, D. C.
Shields, H. C., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Sisk, E. H., Jr., Navy Department, Washington, D. C.
Smith, L. N., Automatic Temperature Control Company, Philadelphia, Pa.
Staley, C. M., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Stephens, D. L., Consolidated Gas, Electric Light and Power Company, Baltimore, Md.
Stephenson, J. G., Ohio Brass Company, Barberton, Ohio.
Stouch, D. H., Duquesne Light Company, Pittsburgh, Pa.
Stoudt, J. M., Division of Highway Maintenance, Cincinnati, Ohio.
Strehle, P. H., Jr., Brown Instrument Company, Philadelphia, Pa.
Szwalek, S. J., Rural Electification Administration, Washington, D. C.
Tate, J. B., Jr., Naval Ordnance Laboratory, Navy Yard, Washington, D. C.
Taylor, A. B., General Electric Company, Philadelphia, Pa.
Towner, C. N., United States Engineer Office, Cincinnati, Ohio.
Tragesser, H. R., Electric Controller and Manufacturing Company, Cleveland, Ohio.
Tudor, J. A., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Penna.
Vaughan, T., Jr., Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Wagner, C. E., United States Naval Reserve, Washington, D. C.
Wagner, T. B. P., Bethlehem Steel Company, Baltimore, Md.
Weimer, F. C., Ohio State University, Columbus, Ohio.
Weiss, W. A., Hygrade Sylvania Corporation, Emporium, Pa.
Welbourne, W. W., United States Engineers, Cincinnati, Ohio.
Wettlaufer, A. Q., 524 Fulton Street, Port Clinton, Ohio.
Whitehurst, T., General Electric Company, Philadelphia, Pa.
Williamson, A. G., Jr., United States Army, Signal Corps, Fort G. G. Meade, Md.
Willms, G., Jr., Taylor-Winfield Corporation, Warren, Ohio.
Wood, C. W., General Electric Company, Philadelphia, Pa.
Zarger, E. A., Potomac Edison Company, Waynesboro, Pa.

3. New York City

Annett, E. B., Jr., Western Electric Company, Kearny, N. J.
Bartman, F. L., Westinghouse Lamp Division, Bloomfield, N. J.
Beagan, W. J., Navy Yard, New York, N. Y.
Bertero, E., National Broadcasting Company, New York, N. Y.
Boyle, M. R., Watson Elevator Company, Englewood, N. J.
Brockman, J. J., United States Army, Fort Monmouth, Red Bank, N. J.
Calabrese, J. F., Signal Corps Laboratories, Fort Monmouth, N. J.
Casabona, A. M., International Telephone and Radio Laboratories, New York, N. Y.
Case, R. L. (Member), Bell Telephone Laboratories, Incorporated, New York, N. Y.
Cheney, C. P., 54 Boulevard, Summit, N. J.
Cheney, W. G., Westinghouse Electric and Manufacturing Company, New York, N. Y.
Davis, H. R., Brooklyn, Edison Company, Brooklyn, N. Y.
deGraaff, J. R., Westinghouse Lamp Division, Bloomfield, N. J.
Deutsch, R. (Member), Tunnel Authority, New York, N. Y.
Dolbear, R., 29 Martin Terrace, Hackensack, N. J.
Entrekin, G. B., Jr., United States Army, Signal Corps, Fort Monmouth, Red Bank, N. J.
Everest, G. N. (Member), The Okonite Company, Passaic, N. J.
Falconett, C. J., Sperry Gyroscope Company, Brooklyn, N. Y.
Faltin, J. W., Long Island Lighting Company, Roslyn Heights, N. Y.
Fleckenstein, E. D., United States Navy, U.S.S. Beaver, % Postmaster, New York, N. Y.
Friedland, K., United States Engineer Office, War Department, New York, N. Y.
Goetz, E. A., Arma Corporation, Brooklyn, N. Y.
Goode, H. T., Ford, Bacon and Davis, New York, N. Y.
Haas, W. C., Consolidated Edison Company of New York Incorporated, New York, N. Y.
Harnett, L. T., Kenyon Transformer Company, New York, N. Y.
Haskins, R., Jr., Sperry Gyroscope Company, Incorporated, Garden City, N. Y.
Heimes, D. L., Signal Corps, United States Army, Fort Monmouth, Red Bank, N. J.
Hoisington, D. B., Hazeltine Service Corporation, Little Neck, N. Y.
Hutchins, W. R., Columbia University, New York, N. Y.
Intintola, J. A., Westinghouse Electric and Manufacturing Company, Newark, N. J.
Joel, A. E., Jr., Bell Telephone Laboratories, Incorporated, New York, N. Y.
Kamm, L. J., Signal Engineering and Manufacturing Company, New York, N. Y.
Kirkwood, L. W., Bell Telephone Laboratories, Incorporated, New York, N. Y.
Knights, J. E., Jr., 6113 62nd Street, Maspeth, Queens, N. Y.
Kutel, S. S., American Transformer Company, Newark, N. J.
Laidig, J. F., Bell Telephone Laboratories, Incorporated, New York, N. Y.
Lee, J. A., United States Naval Reserve, U.S.S. 0-7, % Postmaster, New York, N. Y.
Loehr, W. F., General Cable Corporation, Bayonne, N. J.
MacGregor, R. R., American Telephone and Telegraph Company, New York, N. Y.
Martin, E. J., Sperry Gyroscope Company, Incorporated, Brooklyn, N. Y.
Mason, J. J., Westinghouse Electric and Manufacturing Company, Bloomfield, N. J.
Mehring, A. C., Westinghouse Electric and Manufacturing Company, Newark, N. J.
Moore, J. F., General Electric Company, New York, N. Y.
Morris, F. A., Jr., International Standard Electric Company, New York, N. Y.
Nordhem, A. D., Curtiss-Wright Corporation, Caldwell, N. J.
Odarenko, T. M. (Member), Bell Telephone Laboratories, Incorporated, New York, N. Y.
Ordonez, C. M., Arthur Harris, 90 West Street, New York, N. Y.
Oriel, C. W., Public Service Electric and Gas Company, Elizabeth, N. J.
Papamarcos, J., Navy Yard, Brooklyn, N. Y.
Pelitsch, E. J. J., Sperry Gyroscope Company, Brooklyn, N. Y.
Pessagno, T. S., Postal Telegraph-Cable Company, New York, N. Y.
Pinkham, H. G., Jr., Ford Instrument Company, Incorporated, Long Island City, N. Y.
Ragazzini, L. J., Ward Leonard Electric Company, Mount Vernon, N. Y.
Rathje, E., Jr., Control Instrument Company, Brooklyn, N. Y.
Rychlovsky, A. A., Westinghouse Electric Elevator Company, Jersey City, N. J.
Schroder, J. H. (Member re-election), Public Service Electric and Gas Company, Newark, N. J.
Shmurak, B., American Can Company, New York, N. Y.
Stavitski, L. X., Sperry Gyroscope Company, Incorporated, Brooklyn, N. Y.
Stevenson, J. M., United States Army, Signal Corps, Fort Monmouth, Red Bank, N. J.
Sulzer, J. H., Western Electric Company, Inc., Kearny, N. J.
Tarasuk, N., Westinghouse Electric and Manufacturing Company, Newark, N. J.
Thalmann, E. H., Ebasco Services, Inc., New York, N. Y.
Traupe, W. F., 808 East 234 Street, New York, N. Y.
Trimble, R. F. (Associate re-election), J. Livingston, and Company, New York, N. Y.
Tse, F. S., Ebasco Services, Incorporated, New York, N. Y.
Watson, C. W., United States Army, Signal Corps, Fort Monmouth, N. J.
Watson, M. E., United States Navy, 3rd Naval District, New York, N. Y.
Wells, J. A., United States Navy, U.S.S. Barnegat, % Postmaster, New York, N. Y.
Wilcox, J. G., New York and Queens Electric Light and Power Company, Flushing, N. Y.
Wimpie, S., City College of New York, New York, N. Y.
Wooley, R. L., International Telephone and Radio Manufacturing Corporation, Newark, N. J.
Young, J. S., United States Navy, U.S.S. Plunkett, % Postmaster, New York, N. Y.
Young, N. S., Westinghouse Electric and Manufacturing Company, New York, N. Y.
Yozzo, A. A., George G. Sharp, New York, N. Y.

4. Southern

Balaban, S. F., 329 Fairfax Avenue, Norfolk, Va.
Boedecker, H. W., United States Army, Signal Reserve, Camp Livingston, La.

Church, H. E., Jr., Aluminum Company of America, Alcoa, Tenn.
Curry, A. M., Aluminum Company of America, Alcoa, Tenn.
de Forest, C. S. (Associate re-election), United States Navy Yard, Charleston, S. C.
Duncan, R. K., Norfolk Navy Yard, Portsmouth, Va.
Freeman, W. C., Tennessee Valley Authority, Cherokee Dam, Tenn.
Gilmore, J. F., Ordnance Department, United States Army, Eglin Field, Fla.
Hargett, Y. S., United States Army, 17 Engineer Battalion, Fort Benning, Ga.
Harris, L. J., Aluminum Company of America, Alcoa, Tenn.
Hay, R. A., United States Naval Proving Ground, Dahlgren, Va.
Kovacevic, S., Coast Artillery, United States Army, Camp Davis, N. C.
Lantz, F. L., Giffels and Vallet, Inc., Norfolk, Va.
Linke, S., Electric Power and Water Board, Knoxville, Tenn.
Mc Rorie, W. F., Carolina Power and Light Company, Asheville, N. C.
Phillips, R. L. (Member), Louisiana Power and Light Company, Sterlington, La.
Rackley, L. E., Tennessee Valley Authority, Knoxville, Tenn.
Ravenel, B. W., Jr., United States Army, Signal Corps, Camp Polk, La.
Sams, W. T., Ordnance Department, United States Army, Fort Bragg, N. C.
Shafer, H. J., National Advisory Committee for Aeronautics, Langley Field, Va.
Siegel, R., 703 Russell Road, Alexandria, Va.
Simpson, H., United States Engineers, Jacksonville, Fla.
Sprankle, C. H., 93rd Engineers Battalion, Camp Livingston, La.
Tang, W. G., Welles Engineering Company, Front Royal, Va.
Truman, F. L., Tennessee Valley Authority, Wilson Dam, Ala.
Warren, M., Jr., Aluminum Company of America, Alcoa, Tenn.
Wear, J., Ashland Oil and Refining Company, Ashland, Ky.
Webb, R. C., United States Army, Signal Corps, Wilmington, N. C.
Whitaker, J. C., American Telephone and Telegraph Company, Atlanta, Ga.

5. Great Lakes

Belderr, V. A., Harnischfeger Corporation, Milwaukee, Wis.
Britton, H. E., General Electric Company, Fort Wayne, Ind.
Cassidy, T. D., Commonwealth Edison Company, Chicago, Ill.
Claussen, L. W., American Telephone and Telegraph Company, Chicago, Ill.
Davidson, W. D., Michigan Bell Telephone Company, Grand Rapids, Mich.
Dryer, H. V., Line Material Company, South Milwaukee, Wis.
Dvorak, E. J., Interlake Iron Corporation, Chicago, Ill.
Ely, H. D., Public Service Company of Northern Illinois, Chicago, Ill.
Eng, W. T., Chicago Transformer Corporation, Chicago, Ill.
Erikstrup, C. K. (Member), Ford Motor Company, St. Paul, Minn.
Green, J. A., Collins Radio Company, Cedar Rapids, Iowa.
Hage, W. C., Commonweath Edison Company, Chicago, Ill.
Hansen, H. B., Allis-Chalmers Manufacturing Company, Milwaukee, Wis.
Hensel, H. W., Patterson and Emde, Chicago, Ill.
Huber, G. R., United States Army, Signal Corps, Fort Custer, Mich.
Johnson, M. R., Jr., General Electric Company, Fort Wayne, Ind.
Kalmbaugh, W. L., Allis-Chalmers Manufacturing Company, Milwaukee, Wis.
Kincaid, G. R., Public Service Company of Northern Illinois, Chicago, Ill.
Kintner, P. M., General Electric Company, Fort Wayne, Ind.
Knotts, J. A., Jr., General Electric Company, Fort Wayne, Ind.
Lash, E. E., United Engineers and Constructors, Alton, Ill.
Leland, H. E., Allis-Chalmers Manufacturing Company, Milwaukee, Wis.
Lonsdale, E. M., Iowa State College, Ames, Iowa.
Matthews, G. J., Commonweath Edison Company, Chicago, Ill.
Maul, J. A., General Electric Company, Fort Wayne, Ind.
McConnell, K. R., Michigan Bell Telephone Company, Battle Creek, Mich.
Mendelsohn, M., Lindberg Engineering Company, Chicago, Ill.
Middlecoff, H. W., Allis-Chalmers Manufacturing Company, Milwaukee, Wis.
Mohr, G. R., Allen Bradley Company, Milwaukee, Wis.
Monfon, L., Doolittle Radio, Incorporated, Chicago, Ill.
Moore, R. E., Allis-Chalmers Manufacturing Company, Milwaukee, Wis.
Ogel, K. H., 803 South State Street, Ann Arbor, Mich.
Pedersen, I. C., Zenith Radio Corporation, Chicago, Ill.
Peterson, H. A., Jr., Automatic Electric Company, Chicago, Ill.
Peterson, R. A., S. Heller Elevator Company, Milwaukee, Wis.
Petterman, J. L., Traffic Engineering Bureau, Detroit, Mich.
Richardson, G. A., Commonweath Edison Company, Chicago, Ill.
Romero, E. S., General Electric Company, Fort Wayne, Ind.
Rowe, R. F., General Electric Company, Fort Wayne, Ind.
Schapira, W., Ohmite Manufacturing Company, Chicago, Ill.
Schirf, V. E., Oliver Farm Equipment Company, South Bend, Ind.
Shuler, M. H., University of Minnesota, Radio Station WLB, Minneapolis, Minn.
Snyder, A. D., Automatic Electric Company, Chicago, Ill.
Snyder, H. W., Allis-Chalmers Manufacturing Company, West Allis, Wis.
Steffins, M. R., Michigan Bell Telephone Company, Detroit, Mich.
Uline, B. A., Nappanee Utilities Company, Nappanee, Ind.
Voican, N., American Brakeblok, Detroit, Mich.
Wadleigh, K. H., Commonwealth Edison Company, Chicago, Ill.
Wainright, J. A., Illinois Bell Telephone Company, Chicago, Ill.
Weden, E. A., 4650 Park Avenue, Minneapolis, Minn.
Wetzel, T. A. (Member), Kearney and Trecker Corporation, West Allis, Wis.
Wisman, F. O., Bendix Aviation Corporation, South Bend, Ind.
Woll, H. J., RCA Manufacturing Company, Indianapolis, Ind.
Zahorsky, L. A., General Electric Company, Fort Wayne, Ind.

6. North Central

Barnum, R. T., Westinghouse Electric and Manufacturing Company, Denver, Colo.
Bossard, R. L., U. S. Bureau of Reclamation, Denver, Colo.
Bradley, J. T., Sedgwick County Electric Company, Ovid, Colo.
Cartwright, K. O., United States Army, Fort F. E. Warren, Wyo.
Clark, D., U. S. Bureau of Reclamation, Denver, Colo.
Dennis, D. H., Remington Arms Company, Denver, Colo.
Dowis, W. J. (Member), Remington Arms Company, Lakewood, Colo.
Ecker, A. J. (Associate re-election), U. S. Bureau of Reclamation, Denver, Colo.
Fletcher, W. H., U. S. Bureau of Reclamation, Denver, Colo.
Hinch, W. H., U. S. Bureau of Reclamation, Denver, Colo.
Jackson, A. R., United States Army, Ordnance Plant, Denver, Colo.
Lalor, J. Q. (Associate re-election), 1125 South Vine St., Denver, Colo.
Stoskopf, E. G., Fairbanks Morse and Company, Denver, Colo.
Wilson, F. M., U. S. Bureau of Reclamation, Denver, Colo.

7. South West

Arnold, H. J., Jr., 1225—14th Street, Arkadelphia, Ark.
Beam, R. E., Southern Methodist University, Dallas, Texas.
Blackburn, C. W., Phillips Petroleum Company, Bartlesville, Okla.
Braun, G. M., Petty Geophysical Laboratories, San Antonio, Texas.
Chapman, P. E., P. E. Chapman Electrical Works, St. Louis, Mo.
Conger, A. C., United States Army, Fort Leonard Wood, Mo.
Coover, M. P., United States Army, Corps of Engineers, Fort Leonard Wood, Mo.
Cowles, R. J., United States Naval Reserve, St. Louis, Mo.
Dale, J. R., Jr., United States Air Corps, Kelly Field, Texas.
Duce, T. E., 433 Palmero, Corpus Christi, Texas.
Finley, F. W., Frank Horton and Company, Lamar, Mo.
Gilbert, R. A., United States Army Air Corps, Ellington Field, Texas.
Gulinson, J. L., Federal Power Commission, Fort Worth, Texas.
Kaufmann, J. J., Texas Company, Port Arthur, Texas.
Killen, C. G., Jr., Magnolia Petroleum Company, Lamesa, Texas.
Pelster, A. F., Bussmann Manufacturing Company, St. Louis, Mo.
Schulke, A. A., Washington University, St. Louis, Mo.
Scott, G. H., Crossett Lumber Company, Crossett, Ark.
Skinner, E. E., United States Army, Signal Corps, Dallas, Texas.
Stover, E. B., Jr., Stanolind Oil and Gas Company, Tulsa, Okla.
Twiss, F. C., Anti-Aircraft Training Center, Radio School, El Paso, Texas.
Wachter, L. J., Company D, 29th E. T. Battalion, Fort Leonard Wood, Mo.

8. Pacific

Austin, H. B., United States Army, 9th Corps Area, San Francisco, Calif.
Brown, S. K., Jr., Lockheed Aircraft Corporation, North Hollywood, Calif.
Coe, R. N., Southern California Edison Company, Limited, Los Angeles, Calif.
Deniston, W. L., Bethlehem Shipbuilding Company, Terminal Island, San Pedro, Calif.
Hedene, P. S., Mare Island Navy Yard, Vallejo, Calif.
Humphreys, R. W., Bethlehem Steel Corporation, San Francisco, Calif.
Ingersoll, E. R., General Electric Company, Los Angeles, Calif.
Lovelace, S. N., Kaiser Company, Incorporated, Richmond, Calif.
Olivier, G. I., Jr., United States Engineer Office, San Francisco, Calif.
Possner, J. B., Consolidated Steel Corporation, Limited, Wilmington, Calif.
Powell, J. W. E., United States Naval Reserve, Naval Air Station, Alameda, Calif.
Schull, G. R., Box 25, Cortaro, Ariz.
Scott, W. K., Columbia Steel Company, Pittsburg, Calif.
Shapero, C. B., Pacific Gas and Electric Company, San Francisco, Calif.
Skift, E. W., United States Electrical Motors, Los Angeles, Calif.
Swank, J. W., Southern California Edison Company, Limited, Los Angeles, Calif.
Urlovic, W. C., Pacific Gas and Electric Company, San Francisco, Calif.
Wohlford, J. G., United States Army, San José, Calif.

9. North West

Anderson, G. V., Bonneville Power Administration, Portland, Ore.
Curtin, J. R., Bonneville Power Administration, Portland, Ore.
Dalcerro, A., State Water Conservation Board, Helena, Mont.
Grant, E. F., Oregon State College, Corvallis, Ore.
Shirrod, I. R., International Business Machines Corporation, Butte, Mont.
Siegal, A., Boeing Aircraft Company, Seattle, Wash.
Tack, P. B., Westinghouse Electric and Manufacturing Company, Portland, Ore.
VonLossow, R. L. (Member), Westinghouse Electric and Manufacturing Company, Seattle, Wash.

10. Canada

Dafoe, W. A. V., Radio Valve Company of Canada, Limited, Toronto, Ont.
Gregory, A. J., English Electric Company, St. Catharines, Ont.
Hailey, A. R. T., Canadian General Electric Company, Peterborough, Ont.
Henderson, R. C., Bell Telephone Company, Toronto, Ont.
Honey, J. E. M., Moloney Electric Company of Canada, Ltd., Toronto, Ont.
Mole, H. W., Royal Canadian Ordnance, Toronto, Ont.
Pashler, P. E., National Research Council of Canada, Toronto, Ont.
Scott, R., Canadian General Electric Company, Ltd., Peterborough, Ont.
Smith, H. P. Aeronautical Engineering School, Montreal, Que.
Story, G. L., Hydro-Electric Power Commission, Toronto, Ont.
Waller, M. J., Northern Electric Company, Limited, Montreal, Que.
Wilson, H. L., Bell Telephone Company, Toronto, Ont.

Total, United States and Canada, 466

Elsewhere

Aziz, M. M., Kotliloharan, East (Sialkot) India.
Caldwell, L. E., Standard Oil Company of Venezuela, Quiriquire, Venezuela, S. A.
Duraiswami, T. M., Messrs. Chari and Chari, Ltd., Second Line Beach, Madras, India.
Huaitalla, E. M. (Member), Compagnie des Mines de Huaron, Shelby Huaron, Peru.
Humphrey, W. R., United States Army Engineers, Anchorage, Alaska.
Mercado, E. J., Puerto Rico Telephone Company, San Juan, P. R.
Pita, A. G., Cespedes 125, Sagua la Grande, Cuba.
Reuss, G. W., War Department, Corps of Engineers, Trinidad District, British West Indies.
Tieman, C. R., United States Army, Signal Corps, Honolulu, T. H.
Woolfson, M. (Member), Royal Naval Volunteer Reserve, Ardencaple Castle, Helensburgh, Dumbartonshire, Scotland.
Young, L. F., Ketchikan Public Utilities, Ketchikan, Alaska.
Yousaf, S. M., Public Works Department, Lahore, India.

Total, elsewhere, 12

OF CURRENT INTEREST

WAR PROGRAM . .

Government Program to Speed Metals Production

A two-point Government-sponsored program to meet urgent wartime demands for greatly increased domestic mine production of copper, lead, and zinc over the next $2^1/_2$ years was announced recently. Participation by Metals Reserve Company in the program was made known by Jesse Jones, Federal Loan Administrator.

The program involves:

1. Payments by Metals Reserve Company (subsidiary of the Reconstruction Finance Corporation) of premium prices, substantially higher than the ceiling prices, for any production of these metals in excess of quotas. These premium prices will be 17 cents per pound for copper, 11 cents for zinc, and $9^1/_4$ cents for lead; and maintenance of these prices for overquota production will be assured for a period of $2^1/_2$ years, beginning February 1, 1942.

2. An increase from 5.85 cents to 6.50 cents a pound, New York, in the ceiling price for lead. There is no change in the ceiling price of $8^1/_4$ cents per pound, East St. Louis, for zinc, or in the 12 cents per pound ceiling price for copper. Price schedules will be issued by the Office of Price Administration establishing a maximum base price of 6.50 cents on primary lead and also establishing ceiling prices for secondary lead, bearing the proper relation to the 6.50-cent price for primary lead.

In general, the quotas assigned to companies now already producing any of these metals will be based on their output in 1941. Production in excess of these quotas and production from companies not now operating will for the most part be eligible for the premium prices, and will, in general, represent higher-cost metals which otherwise would not be produced. Thus, the premium price arrangement continues the principle of differential prices for low- and high-cost production heretofore followed by the Office of Price Administration.

Engineers Defense Board Makes Steel Conservation Suggestions

Specific recommendations for conservation of steel in a wide range of uses have been made to the War Production Board by the Engineers' Defense Board, technical group sponsored by the American Society of Civil Engineers, The American Society of Mechanical Engineers, the American Institute of Mining and Metallurgical Engineers, AIEE, the Society of Automotive Engineers, and the American Institute of Chemical Engineers (*EE, Dec. '41, p. 610–11*).

In a letter addressed to H. LeRoy Whitney, chief, technical and engineering section, Iron and Steel Branch, WPB, the Engineers' Defense Board suggests changes in Federal specifications to encourage greater salvage activities, the issuance of special appeals for increased salvage of steel regardless of profit possibilities, and adoption by municipalities and political subdivisions of an emergency manual to liberalize types of construction materials, working stresses, etc., to effect material reductions in quantities of steel used.

Recommending immediate preparation of manual agreed upon by all commercial, technical, and military interests, the Board urges that its provisions be made applicable to all structures needed for the national emergency, bearing in mind that many will be of a temporary nature.

It urges also that steel may well be conserved in bridge construction by recognizing as standard for the design of railway bridges, the 1941 edition of the Specifications for Steel Railway Bridges of the American Railway Engineering Association.

WPB Industry Operations Division to Control Priorities, Requisitions

Authority to operate the priorities system and to administer regulations under requisitioning acts was officially vested in James S. Knowlson, director of the Division of Industry Operations, by regulations 1 and 2 of the War Production Board issued January 27 by Donald M. Nelson, WPB chairman.

The authority delegated to the Director of Industrial Operations includes power to issue priority orders and regulations; to compel the acceptance of war orders by producers and manufacturers; to requisition the property of any person or firm which is needed for the war effort, in accordance with Federal statutes; and to approve requisitions of other Federal agencies. The power to ration products at the retail level is, however, reserved to the Office of Price Administration by directive number 1 of the chairman of the War Production Board, which was also issued January 27.

Silver Gains Industrial Uses

Use of silver, one of the few metals not on the critical list, in millions of electrical contacts is an example of the rapid increase in industrial uses of that metal. Further industrial uses are to be expected as engineers learn to forget that silver is a "precious" metal and put it into service in the everyday jobs to which it is suited.

Sterling silver, containing 925 parts fine silver and 75 parts copper, is one of the silver alloys used in electrical contacts which can be hardened by heat treatment as well as by cold working. Sterling silver heated to 700 degrees Fahrenheit and quenched has a Scleroscope hardness of 23 and a Rockwell hardness of 47. Also used in contacts are fine silver, coin silver, and various proprietary alloys and mechanical mixtures.

Fine silver wire is being used to replace fine copper wire for small coils in many electrical applications. Advantages of silver in electrical applications are its electrical conductivity, which is higher than that of any other metal, and its high resistance to corrosion. Also silver is plentiful, while copper is being restricted for defense needs. Although the cost per pound of silver is much greater than that of copper, other factors somewhat reduce the difference in total cost.

Another increasing use of silver is in coating the reflecting surfaces of "sealed beam" head lamps for automobiles and of large incandescent lamps used in defense plants. Both silver and aluminum had been used for the reflectors incorporated in these lamps; defense requirements are causing the trend to silver. Recent tests reported to the American Optical Society indicate that silver leads in ability to reflect light, reflecting 95 per cent as compared to 88 per cent by aluminum and 82 per cent by gold.

Educators Confer on Co-operative War Plans

Approximately 1,000 college and university presidents, representing 46 of the United States, Canada, and Puerto Rico, met at a two-day conference held recently at Baltimore, Md., under joint sponsorship of the military affairs committee of the National Committee on Education and Defense and the United States Office of Education. The conference unanimously adopted 15 resolutions, embodying a program of co-operative action between the colleges and the agencies of government.

The resolutions, copies of which were sent to all college presidents, included the following recommendations:

A national survey of man power and the facilities of colleges and universities to meet these needs

Acceleration of college programs

A study of the extent and bases of Federal aid desirable to make such acceleration possible

A study of and the development of plans for the solution of shortages in teacher personnel and related educational fields

The maintenance of standards both in regard to admission and to the granting of credit for military experience

Development of an exchange of information on plans and policies pertaining to defense

Necessity of increasing concern for the physical fitness of the student

A study of the academic calendar for both the secondary school and the college

Endorsement of the principle of Selective Service for the procurement of man power for the armed forces

Occupational deferment of selected premedical, predental, pretheological, and graduate students

Copies of the resolutions are available

free at the office of the American Council on Education, Washington, D. C. The Proceedings of the conference may be procured as soon as printed at a cost not to exceed $1 per copy.

Man-Power Problems

With the Army planning to call for some 1,900,000 additional men during 1942, the Navy for some 300,000 or more, and war and nonwar industries expected to need an additional force of 2,000,000 or more men and women, the problem of man-power supply and allocation is rapidly assuming proportions that inevitably will change very sharply many of the accustomed ways of American life. The second draft registration of February 16, 1942, is widely regarded by competent observers to be a preliminary step toward a full mobilization of American man power from the ages of 18 to 65 to concentrate upon the one major problem represented by the nation's war needs, both in the Services and in the industries upon which modern fighting forces are utterly dependent.

Currently the informed comment indicates the prospect of combatant military service for ages 18 to 36, noncombatant service assignments for ages 36 to 45, and assignment to vital industrial or other needs for the age group 45 to 65 years. Deferments now allowed for dependents seem certain to be curtailed drastically; deferments allowed for anything but the more serious physical deficiencies seem certain to be translated into assignments to noncombatant or less rigorous but none-the-less vital duties; deferments from military service for industrial service even in war industries seem certain to be curtailed drastically. Women are expected to be called into industrial pursuits on a very broad basis.

Engineers for the War Program

How many civilian workers does it take to keep a soldier in the army? The estimates vary. Engineers are among the most important of our civilian workers supporting our "armed forces." Whatever the ratio between the armed and civilian forces, the expanding war program is constantly demanding a new high in the estimates for engineers needed in defense agencies and industries, according to a statement from the United States Civil Service Commission.

The Commission, recruiting for the Federal civil service, is accepting applications for all grades and branches of engineering. Engineer examinations, some recently consolidated and modified, are listed below. None requires a written test. For the Junior grades, $2,000 a year, applicants are rated on their engineering education; no experience is required:

Junior engineer, aeronautical, naval architecture, and marine engineering, Announcement 122. The usual college engineering course must include work in the optional branch chosen unless the applicant has taken an appropriate defense training course, or has had prescribed experience in the branch chosen. Age limit—40 years.

Junior engineer, all other branches of engineering, Announcement 172. A new feature is that certain college courses (other than the usual engineering courses) may also be accepted if supplemented by appropriate engineering defense training courses. Previous Announcement 51 admitted senior college students who will complete prescribed courses by June 30, 1942. The new examination also admits those who will complete such courses by June 30, 1943. Age limit—35 years.

In the upper grades, applicants are rated on education, experience, and record of accomplishments. In all but the chemical engineer examination, professional engineering experience may be substituted for the college work:

Chemical engineer, $2,600 to $5,600, Announcement 163. There is a shortage of engineers experienced in specialized branches of plant layout, equipment design, market analysis, chemical economics, heavy chemicals, plastics, rubber, agricultural by-products, and strategic minerals.

Naval architect, Announcement 98; marine engineer, Announcement 99; $2,600 to $5,600 a year.

Engineer (all other branches) $2,600 to $5,600 a year, Announcement 173. Especially needed, particularly in the associate and assistant grades, are engineers experienced in the following fields: aeronautical, electrical, radio, telephone, mechanical (particularly machine design and development), heating and ventilating, industrial, sanitary, hydroelectric, irrigation, construction-estimating, structural, explosives, plumbing, public health, welding, hydraulic.

For all upper grades the age limit is 60 years except that for the highest three grades of marine engineering and naval architecture—$3,800 to $5,600 a year—the age limit is 70 years.

Age limits do not apply to veterans granted military preference, up to the retirement age. Nonveterans over the age limit will not be eligible for permanent appointment, but they may apply, and, if they meet all but the age requirements, may be listed for defense needs not met through normal means.

There are also opportunities in the subprofessional and lower grades:

Technical assistant (engineering) $1,800 a year, Announcement 177. Three years of a 4-year college course must be shown including work in mathematics, physics, and allied engineering subjects. Appropriate engineering defense training courses will satisfy a part of the requirements. The age limit is 53 years.

Engineering aid, photogrammetric and topographic options, $1,440 to $2,600 a year, Announcement 206. This examination has just been reissued to add the junior engineering aid position paying $1,440 a year, and to modify the requirements in order to attract additional applicants needed in connection with the national defense mapping program recently set up in the War Department. Appropriate civil engineering experience, partly in the optional branch chosen, and high school education (or additional engineering experience), are required. Provision is made for the substitution of appropriate college study or defense training courses, or study in a resident night school or technical institute, for the engineering experience. No substitution will be allowed, however, for the specialized experience or training in photogrammetry or topography. Age limit—53 years.

Other opportunities for engineers are offered by the following:

Engineering draftsman, junior to chief grades, $1,440 to $2,600 a year, Announcement 174. This examination supersedes a number of others and includes 20 different optional branches. Engineering education is one of the alternative or substituted requirements. Age limit—55 years.

Applications for these positions are being accepted for several months or until further notice. Qualified engineers are urged, however, to apply at once, unless they have already applied in a recent examination and are eligible, for the position desired. Full information is given in the announcements which may be obtained with the proper application forms, at any first- or second-class post office or from the U. S. Civil Service Commission, Washington, D. C.

Defense Job for "Electric Eye". Use of an "electric eye" or photoelectric tube to turn off night lights in the event of a black-out has been devised by Andrew Tessier, machine-shop proprietor in Schenectady, N. Y. The tube is installed in the shop window, focused on the street light at the corner. When the street light goes out, which will happen immediately after an air-raid warning is sounded, all lights in the shop will be extinguished also; when the street lights come on again, so will the lights in the shop. The equipment is inexpensive, providing a practical solution for businesses which benefit from the use of lights at night but cannot afford the services of a night watchman to turn out lights in the event of black-outs.

OTHER SOCIETIES •

ASTM Adds Chapters. Four new local chapters have been chartered by the American Society of Tool Engineers, bringing the total to 47, according to announcement. The new chapters are at San Diego, Calif.; Fond du Lac, Wis.; Portland, Maine, and Akron, Ohio. Their chairmen are: John J. Tucker, Quartermaster Corps, United States Naval Air Station, San Diego; K. P. Gallimore, vice-president

Future Meetings of Other Societies

American Chemical Society. April 20–24, 1942, Memphis, Tenn.

American Institute of Chemical Engineers. 34th semiannual meeting, May 11–13, 1942, Boston, Mass.

American Railway Engineering Association. Annual convention, March 17–19, 1942, Chicago, Ill.

American Society for Testing Materials. 45th annual meeting, June 22–26, 1942, Cleveland, Ohio.

American Society of Mechanical Engineers. Spring meeting, March 23–25, 1942, Houston, Tex.

Edison Electric Institute. Annual convention, June 1–4, 1942, Atlantic City, N. J.

Electrochemical Society. Spring convention, April 15–18, 1942, Nashville, Tenn.

Institute of Radio Engineers. Summer convention, June 29–July 1, 1942, Cleveland, Ohio.

Midwest Power Conference. 5th annual meeting, April 9–10, 1942, Chicago, Ill.

National Electrical Manufacturers Association. May 10–15, 1942, Hot Springs, Va.

National Fire Protection Association. May 11–15, 1942, Atlantic City, N. J.

in charge of engineering, Giddings and Lewis Machine Tool Company, Fond du Lac; Edwin R. Andrews, Hyde Windlass Company, Bath, Maine, Portland; Edwin S. Woodhall, manager plant engineering, Goodyear Aircraft Corporation, Akron.

JOINT ACTIVITIES

New Guidance Booklet Issued by ECPD

"Engineering as a Career," a vocational-guidance booklet for high-school students and their advisers, has just been issued by the Engineers' Council for Professional Development. The new booklet replaces ECPD's original guidance booklet, "Engineering—a Career, a Culture," presenting a similar scope of information in an entirely revised and reorganized form.

Dedicated to "the coming generation of engineers and the contributions they will make to the life and culture of mankind," the booklet is divided into two principal sections. The first, "The Scope of Engineering," deals with the engineering profession as a unit, emphasizing the characteristics and requirements common to all its branches, and defining the "engineering method." The aptitudes and personal qualities needed to make a success in the profession, the general educational preparation, and probable opportunities and earnings are among the topics covered.

The second part of the booklet is devoted to a more detailed presentation of activities in the principal branches of the engineering profession. While each of the chief divisions is given separate treatment, the interrelationships are constantly emphasized, and consideration is also given to other fields of activity in which engineers can put their training to effective use. A list of books and pamphlets on vocational guidance, especially in relation to engineering, constitutes a final section of the booklet. Copies may be obtained from ECPD headquarters, 29 West 39th Street, New York, N. Y., at ten cents a single copy; discount on quantity orders.

INDUSTRY • • • • •

Fluorescent Lighting Association Formed

The Fluorescent Lighting Association, with headquarters at 509 Fifth Avenue, New York, N. Y., has been organized recently as a wartime measure by manufacturers of fluorescent tubing and component materials in an attempt to provide maximum illumination from a minimum of materials, the supply of which is limited by restrictions and priorities. Close contact is being maintained with Government officials and bureaus charged with conserving and releasing materials.

The Association aims also to act as a clearing house of practical information on the cold-cathode fluorescent lighting by making standard specifications available to engineers, architects, lighting contractors, and industrial plants and by issuing information to the technical and trade press from time to time. A committee on standards has been formed to make tests and studies in an attempt to standardize fluorescent colors. Plans are in progress for a manual on cold-cathode continuous-tube illumination as distinguished from the common hot-cathode fluorescent lamps.

Fifth Conference Held on Broadcast Engineering

The fifth annual Broadcast Engineering Conference, sponsored by the department of electrical engineering, Ohio State University, with the co-operation of the National Association of Broadcasters and the Institute of Radio Engineers was held February 23–27, 1942, Columbus, Ohio. The conference was devoted almost entirely to problems created by war conditions. In a panel on broadcast-station operation during wartime, such topics as priorities and procurement, fire fighting and property protection, telephone lines, battery-operated equipment for emergency use, radiobroadcast silencing systems, temporary and auxiliary antennas, and emergency equipment were discussed. The problem of training engineers and technicians for replacement and the assistance which broadcast station engineers can give in the training of technicians for military service were considered in the round table discussion led by W. L. Everitt (F'36). The conference again served as the engineering convention of the NAB.

Power Conference to Meet at Chicago

The Midwest Power Conference will hold its fifth annual meeting at Chicago, Ill., April 9–10, 1942, with a program recognizing the significance of power in the war effort. The conference is sponsored by the Illinois Institute of Technology with the co-operation of nine other midwestern colleges and universities and the local Sections of engineering societies.

The program of this year's conference, according to early announcements, will include sessions on electric-power transmission, industrial power plants, hydroelectric power, fuels and combustion, Diesel power, and central-station practice. Two joint luncheons are planned, one with the AIEE Chicago Section, and the other with the Chicago Section of the American Society of Mechanical Engineers, which also is sponsoring the session on central-station practice. An All-Engineers dinner is scheduled for the evening of April 9. The conference is open to all persons interested in the field of power.

Former AIEE Editor Dies. George Addison Wardlaw, retired, the Bureau of Standards, Washington, D. C., died January 27, 1942. He was graduated from Cornell University in 1893. From 1908 to 1911 he was editor of the AIEE *Proceedings*, at that time the Institute's official journal. During World War I he joined the Ordnance Department, Washington, D. C., and later was transferred to the Bureau of Standards, from which he retired in 1937. He was the author of a book on higher mathematics.

LETTERS TO THE EDITOR

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers; publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.

Measuring Transformer-Winding Temperatures

To the Editor:

The short-circuit or "compromise" method of making load runs on transformers recently has gained favor in comparison with other methods because it requires minimum amounts of time, labor, electric energy, and equipment. During war conditions now prevailing all four factors are at a premium. A recent British paper ("Production Temperature-Rise Tests on Transformers," H. S. Holbrook, Institution of Electrical Engineers *Journal*, 1941, page 245) proposes that during the present emergency all temperature-rise tests be limited to six hours' duration. Such a run is made at constant watts input, and the final top oil rise is inferred by plotting rate of rise (ordinates) against rise (abscissas) on special paper and determining the intercept at zero rate of rise by straight-line extrapolation.

Another advantage of the short-circuit method is that the average winding temperature can be calculated from a wattmeter reading at any time, without shutting down the run. To do this, the watts input at room temperature is measured at a selected current, and the d-c resistances are also taken. From these data the watts loss at higher temperatures is calculated in the usual way by assuming that temperature changes have opposite effects on the I^2R and the stray-loss components. Subsequently during the run the average copper temperature can be determined by bring-

ing the current to the reference value and reading watts input. The reference current should be high enough to give substantial readings, but not so high as to jump the temperature appreciably during the 20 or 30 seconds needed for reading the meters; reference currents of 150 and 200 per cent of full load rating give good results. If the meters are read with care comparable to that exercised in making ratio checks the probable accuracy of the temperature determination under the previous assumptions is about plus or minus one degree centigrade. More serious discrepancies may arise from the fact that the stray losses do not always vary with temperature in the manner assumed. In an extreme case with large stray loss (15 to 20 per cent of the total) and high temperature rise (about 80 degrees centigrade) the temperature determination thus obtained may be 10 degrees too high. The amount of uncertainty due to this cause is readily seen by plotting temperature against watts: two straight lines are drawn through the room-temperature reading, one assuming the loss to be entirely I^2R, the other assuming the stray losses to vary inversely with temperature. The true losses will be between the two lines. When such uncertainty is too great, the wattmeter can be calibrated by measuring winding temperatures at one or more values by the increase-in-resistance method. This will also show the amount of temperature difference between windings, which the wattmeter cannot do.

The wattmeter method of measuring winding temperature seems attractive because it is not subject to many of the difficulties of resistance-measurement at the conclusion of a heat run. In the latter case the combination of large winding inductance and rapidly falling winding temperature introduces several troubles which usually require three or more persons, special instruments, and precise procedure in order to obtain accurate results. The wattmeter method is particularly useful in cases where a transformer is to be studied under several different loadings or methods of cooling. It is the only practical method of following the development of temperature gradient between copper and oil after sudden application of large overloads. It is also useful in making short-time overload runs when it is desired to find how long a unit can be operated without exceeding a certain average copper temperature.

JEROME J. TAYLOR (A'40)

Electrical engineer, The Detroit Edison Company, Detroit, Mich.)

New EE Format

To the Editor:

Having had some hand in adapting the Baskerville series for use on the Monotype machine, also in having designed its companion letter, Baskerville Bold, I was naturally interested in noting their thoughtful and interesting use in *Electrical Engineering*.

It seems to me that both faces are particularly fitting for a magazine like *Electrical Engineering*. They are readable types, not too mechanical and still not too aesthetic. Altogether your magazine is much above the average and I congratulate those responsible for its production.

SOL HESS

(Art director, Lanston Monotype Machine Company, Philadelphia, Pa.)

To the Editor:

Your invitation to comment on the "new dress" of *Electrical Engineering*, being buried in the "High Lights," may be just an editor's means of checking to determine who reads the "High Lights" page. This page is a good feature, so I hasten to say so before commenting on the new dress, in case the budgeteers might have designs on it.

I like the new arrangement better than the old. *Electrical Engineering* has consistently been much easier on the eyes than most of today's technical journals, and this new modification is a further step in this direction. Many of your readers are in the bifocal class, and clear type of proper size makes reading much more of a pleasure for them. Congratulations.

W. B. MORTON (M'28)

(Chairman, AIEE Philadelphia Section; senior field engineer, Philadelphia Electric Company, Philadelphia, Pa.)

To the Editor:

In reply to your invitation to comment on the new format, may I say that personally I hope it does not find its way into the *Transactions* because I find it harder to read. There is a lack of co-ordination in reading it due to the spread-out appearance of the letters, as I think reading tests will prove to you. The idea of change is fine, though.

WILLIAM C. URLOVIC (Enrolled Student)

(1358 East 28th Street, Oakland, Calif.)

Editor's Note: That appearances are deceitful is indicated by the fact that the Baskerville type now used in *Electrical Engineering* actually has a higher count of letters to a line of given length than does the more condensed-looking Ronaldson Old Style formerly used and retained in *Transactions*.

To the Editor:

I am writing to congratulate you, and the editorial department, on the new format of *Electrical Engineering*. The "organization" of each issue, the handling of the context, has long been admirable. It is now especially gratifying to find it embodied in this typographically distinguished dress.

You may find the enclosed page from Baskerville's Book of Common Prayer (circa 1760) a matter of interest (see accompanying reproduction). The line "And he faid, Lord, that I may receive my fight" is one of my favorites.

I hope your demonstration of the fact that it is possible to be conservative without being stodgy will be studied by your neighbors, and that your civilizing influence will be widespread—reaching far beyond the bronzes in he hall!

ERNEST FAISANT

(Engineering Societies Building, New York, N. Y.)

The Firft *Day of* LENT.

Son of David, have mercy on me. And Jefus ftood and commanded him to be brought unto him. And when he was come near, he afked him, faying, What wilt thou, that I fhould do unto thee? And he faid, Lord, that I may receive my fight. And Jefus faid unto him, Receive thy fight; thy faith hath faved thee. And immediately he received his fight, and followed him, glorifying God: and all the people, when they faw it, gave praife unto God.

The firft Day of Lent, commonly called Afh-Wednefday.

The Collect.

ALMIGHTY and everlafting God, who hateft nothing that thou haft made, and doft forgive the fins of all them that are penitent; Create and make in us new and contrite hearts, that we worthily lamenting our fins, and acknowledging our wretchednefs, may obtain of thee, the God of all mercy, perfect remiffion and forgivenefs, through Jefus Chrift our Lord. *Amen.*

¶ *This Collect is to be read every day in* Lent, *after the Collect appointed for the day.*

For the Epiftle. JOEL 2. 12.

TURN ye even to me, faith the Lord, with all your heart, and with fafting, and with weeping, and with mourning. And rend your

A page from the Book of Common Prayer printed by John Baskerville in England about 1760

Reproduction one-half actual size

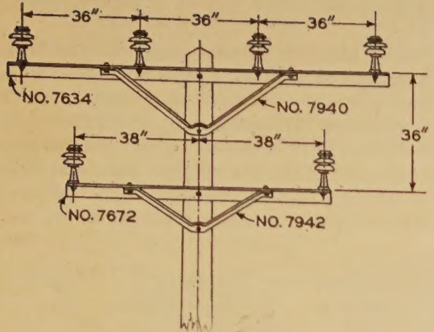
Effects of Ice and Wind on 13,000-Volt Transmission Line

To the Editor:

A short time ago we experienced trouble on two of our distribution circuits, which is recorded in the following paragraphs. It was such an unusual occurrence, being one that we never experienced before in 35 years of operation, that I thought it might be interesting to make a record for the benefit of central-station officials who have yet to experience this phenomenon.

During the late afternoon and evening of Monday, November 24, 1941, the two 13,000-volt circuits from Winnipeg to the town of Transcona were made inoperative when ice and wind combined to cause whipping in the cables of such magnitude that phase-to-phase short circuits occurred.

These circuits run approximately five miles due east of Winnipeg between the City of Winnipeg Hydro Electric System terminal station on Rover Avenue and the substation in the town of Transcona. The two circuits, designated as feeders 81 and



Pole-top construction

Wood poles 45 feet, 6 feet 6 inches in ground

Standard span 150 feet

Cable, 266,800 circular-mil steel-reinforced aluminum

Steel cross arms, 3 1/2- by 3 1/2- by 5/16-inch angle

Top arm 116 inch—4 pin, Slater number 7634

Lower arm 80 inch—2 pin, Slater number 7672

Steel pins, 8 inch above arm, 3/4-inch nut, Slater number 5727

Crossarm braces 1 3/4- by 1 3/4- by 3/16-inch; 1 1/2- by 1 1/2- by 3/16-inch Slater angle brace numbers 7940 and 7942, respectively

Insulators, 27,000 volt Canadian Porcelain, number 3920

82, are run on a wood-pole line constructed as shown in the accompanying illustration.

The circuits are so arranged that two phases of each feeder are on the top arm and the other phase is directly below on the lower arm.

For the first mile the line runs through a well-built-up section of Winnipeg and no trouble was experienced on this section. At the end of this first mile the line is tapped with a number 1/0 copper line running northeast. There was no trouble on the copper line. From this junction point the steel-reinforced aluminum cable continues east over open prairie for the remaining four miles to Transcona.

A summary of weather conditions prior to the occurrence is shown in Table I.

About noon on Friday, November 21, ice was observed on the north side of the cables but there was no visible movement. The number 8 bare solid copper telephone wires

Table I

Date	Temperature High	Low	Mean	Precipitation	Barometer
Wednesday November 19	30.8	25.1	28.0	Trace	
Thursday November 20	18.9	11.1	15.0	.59	29.92
Friday November 21	19.8	3.6	11.7		29.86
Saturday November 22	0.4	−7.1	−3.4		30.28
Sunday November 23	14.5	−7.0	3.8		
Monday November 24	38.3	5.2	21.6	Trace	30.00

on the same poles were jumping a little at this time.

At 11.30 a.m. Monday, November 24, the steel-reinforced aluminum cables were observed to be whipping about eight or ten inches with little or no wind blowing.

Temperatures in degrees Fahrenheit for Monday, November 24, were as follows:

Time	Degrees F	Time	Degrees F
12.01 a.m.	10.0		
1.00 a.m.	10.0	1.00 p.m.	20.0
2.00 a.m.	9.5	2.00 p.m.	22.0
3.00 a.m.	9.0	3.00 p.m.	22.0
4.00 a.m.	9.0	4.00 p.m.	20.5
5.00 a.m.	8.5	5.00 p.m.	20.5
6.00 a.m.	8.0	6.00 p.m.	21.5
7.00 a.m.	7.0	7.00 p.m.	21.5
8.00 a.m.	7.0	8.00 p.m.	23.5
9.00 a.m.	10.0	9.00 p.m.	25.0
10.00 a.m.	15.0	10.00 p.m.	27.0
11.00 a.m.	16.5	11.00 p.m.	30.0
12.00 Noon	18.5	11.59 p.m.	33.5

During the afternoon the wind shifted from west to south and increased in velocity to about 24 miles per hour at 8.00 p.m. The first short circuit occurred at 3.44 p.m. when both circuits tripped by relay. Both circuits were reclosed by hand immediately and held in. Patrolmen were sent out to inspect the line and reported the cables whipping. At 5.13 p.m. both circuits again opened by relay and only feeder 81 was reclosed. It was hoped that the load would be sufficient to remove the ice from this one circuit. This attempt proved unsuccessful and it later became apparent that the lines could not be maintained in service unless the ice was removed.

The oscillation of the cables gradually increased and eventually the cables on one side of the crossarm got out of step with those on the other side. In some spans the cables were oscillating with three waves to a span, in others only one wave to a span. In the spans with only one wave the cables were swinging violently through a distance of approximately 36 inches at midspan. Several 5/8-inch brace bolts sheared off, allowing the upper crossarm to rock with the center bolt acting as an axis. In some cases the crossarm bolts also broke.

For the purpose of burning the ice off the cables, two 6,500-kva generators and one 77-mile 66-kv transmission circuit were isolated from the rest of the system and put on short circuit through the 10 miles of three-phase 13,000-volt overhead conductors between Winnipeg and Transcona.

Feeders 81 and 82 were connected to the bus of the Transcona substation with all other oil circuit breakers open. Feeder 81 was short-circuited at the Rover Avenue station. This system was loaded by slowly increasing the voltage on the two generators as follows:

	Amperes
9.35 p.m.	200
9.37 p.m.	320
9.43 1/2 p.m.	400
9.46 p.m.	400
9.47 p.m.	280

It was observed that the ice was still on the cables and they were still oscillating.

	Amperes
9.59 p.m.	280
10.00 1/2 p.m.	420
10.08 1/2 p.m.	420
10.09 p.m.	220

The cables were now clear of ice and although the wind velocity had not subsided, the movement of the cables had become quite normal.

10.20 p.m. . . Both feeders dead and cleared for repair men.
12.35 a.m. . . Both feeders were again in service.

During the trouble and immediately following the removal of the ice, sufficient replacements of broken crossarm bolts were made to put the line back into service as quickly as possible. Subsequently all breakages were repaired, the full list being shown in Table II.

Table II

	Total Replacement	Percentage of Total on Line
Crossarm and brace through bolts 5/8-inch galvanized, 10 inches and 12 inches	47	6.5
Bolts for crossarms and brace 1/2-inch x 1 1/2-inch galvanized	57	7.9
Insulators	6	
Square galvanized 11/16-inch washers	10	
Spring-lock washers 1/2-inch to 5/8-inch	158 / 30	
Aluminum wire, 266,8000 circular mils	7 lbs	

All tie wires were found to be intact and the cable was burned badly in only one place. The six insulators replaced showed burn marks but were not broken.

JOHN G. GLASSCO (F'28)

(Manager, City of Winnipeg Hydro Electric System, Winnipeg, Man.)

A Matrix Theorem

To the Editor:

In a letter to the editor in the December 1941 issue of *Electrical Engineering*, President A. Pen Tung Sah of the National University of Amoy, Changting, China states and establishes a theorem in matrix algebra which he believes to be new.

The theorem in question is not new and is a special application of Sylvester's theorem on the expansions of functions of matrix polynomials, to the *n*th power of a square matrix of the second order. (See "Elementary Matrices," by R. A. Frazer, W. J. Duncan, and A. R. Collar, Cambridge, 1938, pages 78–9.)

The theorem mentioned by Sah is also established and used in the discussion of electrical networks in the paper, "The Matrix Theory of Four-Terminal Networks," by L. A. Pipes, *The Philosophical*

Magazine, November 1940, pages 370–95, equation 91. A geometrical interpretation of the theorem is given in the paper, "Les Filtres Electriques et la Theorie des Matrices," by L. Brillouin in the *Revue Générale de l'Electricité*, 1936, pages 3–16. From this it appears that the theorem is well known and has been used in connection with electric circuit theory for some time.

LOUIS A. PIPES (A'37)

(Graduate school of engineering, Harvard University, Cambridge, Mass.)

NEW BOOKS • • •

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

Electric Power Stations. Volume 1. By T. H. Carr, with a foreword by Sir L. Pearce. D. Van Nostrand Company, New York, 1941. 376 pages, illustrated, 9 by $5^1/_2$ inches, cloth, $7.50.

This first volume deals mainly with the mechanical-engineering aspects of electric power stations. Topics treated include the circulating water system, cooling towers, coal and ash handling, the boiler plant, pipework, and turbines. Design fundamentals and the construction and layout of buildings also are discussed.

Career in Engineering, Requirements, Opportunities. By L. O. Stewart. Iowa State College Press, Ames, Iowa, 1941. 87 pages, illustrated, 9 by 6 inches, paper, $0.75 single copies; $0.50 for five or more.

With the objective of furnishing information about engineering to young men who are considering a career in that field, the author presents answers for the three standard questions: what does an engineer do; what are the necessary qualifications; and what are the prospects for the future.

Boulder Canyon Project Final Reports. Part IV, Design and Construction. Bulletin 1. General Features. 301 pages; Bulletin 2. Boulder Dam. 253 pages. United States Department of the Interior, Bureau of Reclamation, Denver, Colorado, 1941. Illustrated, $9^1/_2$ by 6 inches, cloth, $2.00 each; paper, $1.50 each.

Bulletin 1 presents general descriptive information about the preliminary construction, the power plant, and other appurtenances to the dam, Lake Mead, and the All-American Canal system. Bulletin 2 presents detailed data regarding the design and construction of the dam itself.

Natural Trigonometric Functions. By Leo Hudson and E. S. Mills. Monroe Calculating Machine Company, Inc., Orange, N. J., $6.

Attempts a new approach to the solution of trigonometric problems by a rapid method not requiring the use of logarithms. Tables of sines, cosines, tangents, cotangents, secants, and cosecants, carried out to eight decimal places, and second differences, carried out to ten decimal places and semiquadrantly arranged, are presented with instructions for use with the Monroe adding-calculator.

Automatic Record Changers and Recorders. By John F. Rider. John F. Rider Publisher, Inc., New York, N. Y., $6.

General and specific facts on mechanism, operation, and care are presented in an effort to provide the serviceman with information on automatic record changers and recorders on the market at present. Manufacturers' service data on record changers and listings of radio-combination model numbers also are supplied.

Curtailment of Non-Defense Expenditures. By Henry P. Seidemann. Published by the Brookings Institution, Washington, D. C., 25 cents.

This recent pamphlet is a report on a study made by the Brookings Institution under a grant from the Falk Foundation, Pittsburgh, Pa.

ASTM Standards on Copper and Copper Alloys. American Society for Testing Materials, Philadelphia, Pa. $2.

The 1941 edition contains 73 standards covering copper and copper alloys in the cast and wrought form, copper and copper-alloy wire used for electrical conductors, and gives requirements for nonferrous metals used in copper alloys.

Iron Men and Their Dogs. By Ferdinand C. Latrobe. Horn-Shafer Company, Baltimore, Md., 1941.

An account of the growth of the Koppers Company, Bartlett Hayward Division, Baltimore, Md., in the production of power-equipment and power transmission equipment, written in an informal style for employees and others interested in the development of the company.

Basic Reference Forms. A Guide to Established Practice in Bibliography, Quotations, Footnotes, and Thesis Format. By G. L. Joughin. F. S. Crofts and Company, New York, 1941. 94 pages, tables, $8^1/_2$ by $5^1/_2$ inches, cloth, $0.80.

Aims to present to the beginning research student a set of basic reference forms for use in documentation. General principles are given for forms of references, methods of assembling them, quotations, footnotes, and the general format of a thesis. Sample reference forms from various special fields are included.

Textbook of the Materials of Engineering. By H. F. Moore, with a chapter by H. F. Gonnerman and J. O. Draffin. Sixth edition. McGraw-Hill Book Company, New York and London, 1941. 454 pages, illustrated, $9^1/_2$ by 6 inches, cloth, $4.

The physical properties of the common materials used in structures and machines, together with descriptions of their manufacture and fabrication, are presented concisely in a form intended for use as a college textbook. The new edition has a chapter on plastics, and extensive changes and additions have been made throughout.

Hello, Goodbye—My Story of Telephone Pioneering. By A. Hibbard. A. C. McClurg and Company, Chicago, 1941. 266 pages, illustrated, 9 by 6 inches, cloth, $2.50.

This volume of reminiscences begins in the lumber country of Wisconsin in 1878, when telephones were a novelty. The scene changes from New York to Chicago for the World's Fair of 1893 and touches briefly on later foreign experiences.

Fatigue of Workers, Its Relation to Industrial Production. By Committee on Work in Industry of the National Research Council. Reinhold Publishing Corporation, New York, N. Y., 1941. 165 pages, $9^1/_2$ by 6 inches, cloth, $2.50.

This volume is the report of the findings of a committee which made a study of variations in working conditions, both physical and psychological, investigating their effect upon the efficiency of workers. The results of this study should be of value to all employers.

Theoretical and Practical Electrical Engineering. Two volumes. By L. D. Bliss. Fifth edition. Bliss Electrical School, Washington, D. C., 1941. Volume 1, 631 pages, Volume 2, 671 pages, illustrated, $9^1/_2$ by 6 inches, cloth, $8 for both volumes.

A course of lectures given at The Bliss Electrical School on the principles and applications of both direct and alternating current apparatus. Discussion of fundamental electrical theories, laws and types of instruments is presented and generators, motors and transformers are treated in detail. Consideration is also given to telegraphy, telephony, electronic devices, illumination, electric railways, and other applications.

The Art of Camouflage. By C. H. R. Chesney. Robert Hale, Ltd., London. Written in 1939, published in 1941. 253 pages, illustrated, 8 by 5 inches, cloth, 8s.6d.

Camouflage, "the art of concealing the fact that you are concealing," is considered both for military and civilian use. The first section discusses camouflage as practiced by creatures in their natural environment, and presents general considerations upon civil camouflage; the second deals with the development of military camouflage in the War of 1914–18, and future developments for both military and civil use; and the final section with strategic camouflage in military movements. The author stresses also the political camouflage which has been demonstrated recently.